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ROYAL PHYSICAL SOCIETY.

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PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION CXX.

Wednesday, 19th November 1890.—GEORGE BROOK, Esq., F.R.S.E., Vice-President, in the Chair.

Dr G. SIMS WOODHEAD, F.R.S.E., retiring Vice-President, delivered the following opening address:—

The Royal Physical Society, one of the oldest scientific societies in the kingdom (Royal Medical Society, founded 1737; Royal Physical Society, founded 1771; Royal Society of Edinburgh, founded 1783; Royal Society, founded 1660; Linnæan Society, founded 1788), has now entered on its 120th session. Great as was the part played by it in the advancement of science in its earlier days up to its eighty-fourth year, it seems to have taken a new lease of life when Hugh Miller began to contribute to its *Proceedings*, and since it began to publish the papers read by its fellows in the form of volumes of *Proceedings*, by the distribution of which its fame has been carried to all parts of the English-speaking world.

On going over these *Proceedings*, we find that they contain a more complete and detailed history of natural science than is to be found in the reports of any other scientific society in Edinburgh; for although we cannot boast the long list of

literary, mathematical, physical, and chemical papers of the Royal Society, for example, the records of the work carried on by the members of this Society, during the last thirty-six years, in the domain of natural and biological science are second to none.

When it is borne in mind that the membership of the Royal Physical Society was originally largely confined to physicians, and that the subjects first discussed at its meetings were those intimately associated with the problems that were daily presenting themselves to those who were engaged in teaching and practising medicine, it would appear that the Royal Physical Society has departed somewhat from the kind of work that its founders intended should be carried on; but when we consider that the students and graduates in the Edinburgh Medical Schools have, according to their best traditions, engaged upon medicine as a life-work that could be built up only on a sound basis of natural and biological science, it is the more readily understood how anything and everything that had even a remote bearing on the everyday studies of these men should come to have an interest apart from its bearing on medicine, an interest that could be shared even by those who were not professed physicians, and how ultimately every man, whose love for science was such as to make him a worker in any of its fields, was welcomed with open arms by the Royal Physical Society.

It thus, naturally enough, happened that as societies arose in which purely medical questions were discussed, the agenda lists of our Society came to include more and more purely scientific papers, and it came about that what we may call pure science gradually assumed to itself the greater share of the attention of our members.

The Royal Physical Society was founded by the professors and students of medicine in the University, and for the first fifty years of its existence we are told that the work engaged on and the papers discussed were almost entirely of a medical nature. That these discussions would be valuable we have sufficient guarantee in the fact that Black, Cullen, Munro, Hope, Gregory, and many others, whose names are now

associated with the foundation, almost, of certain branches of science, took part in them.

The Society, founded in 1771, consisted during the first year of about eighteen members, and during the ten following years there was an average addition of membership of about eighteen per annum. So rapidly was its power augmented, that in 1778 a Royal Charter was applied for and granted, and four years later several other most important societies were amalgamated with it. The whole of the work, however, was still intimately associated with questions connected with medicine, and its work running on lines parallel to that done by the Chirurgo-Medical Society, this latter was one of those that joined with us in 1782.

Like all societies, young and old, its periods of success alternated with periods of great depression; and we are told by the late Mr David Grieve (who recently died, after having been a member of the Society for nearly sixty-three years) that before 1828 there was one of these periods of collapse, and extinction seemed imminent; but the generosity of one man (Professor Dick), and the energy of a few of the members, averted what would have been an irreparable loss to the scientific world. In that year, however, no fewer than seventy-two new members were obtained, whilst in the following year sixty-eight more were enrolled. As we have seen, its membership was made up principally of senior medical students and young graduates, an exceedingly unsatisfactory (because a floating) membership on which to rely for so important a Society, and great efforts were made to entice men of scientific standing outside the medical profession to throw in their lot with their medical brethren to make the Society worthy the name of Royal Physical Society.

As might be expected, the carrying out of such a policy was attended with the best results, and some of the brightest lights that have been thrown on the paths of scientific discovery have emanated from men who were connected with the medical profession only through the meetings held under the ægis of our Society. How great would have been the loss to the annals of the Society were we to delete the fascinating

descriptions of the geology of Edinburgh, of the Old Red Sandstone, and of fossil fishes, contributed by Hugh Miller, narratives which read more like fairy tales than hard scientific records; the wonderful powers of description and narrative, the beauty and power of the language, the keenness of insight, and purity and breadth of thought that characterise all that Hugh Miller wrote, carrying away into the realms of poetry and imagination all but the most prosaic of readers. Hugh Miller contributed to the *Proceedings* of the Society from 1848 to 1856, and who will dare to say that the world is not so much richer through the papers that he gave to that enthusiastic band of geologists, his hearers, both directly by the papers themselves, and indirectly by the enormous influence that such a man must have exerted in moulding the thought and stimulating the ardour of those who had the privilege of coming under the spell of his mind and teaching.

The Peaches, the Geikies, and that long line of geologists of which Edinburgh has been the proud birthplace and nursery, have all been associated with the Royal Physical Society, and have helped to make its name famous in the scientific world.

Here, too, have been attracted men from the theological schools, and Dr Fleming and his colleagues, and more recently Dr Dunn and some of his pupils, have taken their part in the discussions that have been raised on points of natural history, and on the doctrine of evolution as opposed to special creation. Of ornithology, it may be said that in the pages of the Royal Physical Society will be found as many notes on the habits of birds, and on the appearance of species in different localities, as can be found in any magazine or periodical specially devoted to the subject; and Mr Evans, I feel sure, could draw up a list of ornithologists, members of this Society, which would compare most favourably, as regards the work done by them, with any list compiled from the proceedings of any other similar society.

What must strike every one most forcibly in our *Proceedings*, is that the papers recorded in them, given by the younger men, have very frequently indicated the lines on which a great

part of their future work in life was to be carried on; and it cannot but be felt that the Royal Physical Society has thus, through the influence of successive generations of members, played a most important part in laying down the lines of work, and in moulding the intellectual processes of its younger members, that have in after years led to most important results.

In a case of this kind, it is better to give concrete examples than to advance general theories, and I may be allowed to accentuate what I have stated by referring to two such examples only. Our first two presidents, under the new rules of the Society, will serve admirably for our purpose. When Turner was senior demonstrator of anatomy with John Goodsir, he became a Fellow of this Society, and in 1860 gave a paper entitled "Remarks on the Musculus Kerato Cricoideus;" in 1861 we find that he described "The Non-striped Muscle of the Orbit;" and in 1865 gave a "Notice of the Cranium of the Mangunya Negro," thus commencing that series of descriptions of special muscles and of anthropological observations which has made his name famous throughout the scientific world; and we may well say that the foundation of this reputation was laid in these papers, the last of the above-mentioned papers being read nearly two years before the author was chosen as worthy to succeed his great master in 1867.

Similarly, I find that our present distinguished president, Dr Traquair, delivered his first paper, "Note of a Case of Abnormality in the Ossification of the Parietal Bones in the Human Fœtus," on the 7th May 1862; whilst on the 25th of June 1865 he showed the first traces of that specialisation which has since made him one of the greatest, if not the greatest, authority on certain forms of fossil fishes, in a paper entitled "Observations on the Development of the Pleuronectidæ;" so that more than twenty-five years ago the special bent of the work of our two last presidents was determined, and I need not tell members of this Society what part the works of these men have played in the building up of the sciences of anthropology and palæontology respectively.

Gentlemen, I shall not attempt to go into the history of the

Royal Physical Society. This has already been done on previous occasions, by retiring presidents, but I have referred, and should like further to refer, very briefly to a few of the men who, members of this Society, were both physicians and scientific men, and whose names will always be held in reverence by those who seek after truth. I do this for the reason that after my return from Berlin this year, discussing the Congress with a somewhat eminent literary man, I was twitted with the so-called fact that medicine is almost entirely an empirical art, and that medical science, if such a science can be said to exist, is little more advanced than it was fifty or even a hundred years ago. I very naturally attempted to prove a direct negative, and though I was scarcely successful in this, I at least obtained from my friend the admission that the science of medicine is not merely a name. Of course it may be admitted that if by empiricism we mean a system based on a series of observations and facts, then medicine must to a large extent be empirical—but so must all science: no man can argue without facts, and even the logic of induction rests on deductive logic. Put the matter as we will, we know only because we have observed, and the position that we are compelled to take is, that where there are so many scientific minds bringing forth fruit in other fields directly associated with medicine, such minds when brought to bear on their own special work cannot but be influenced in their methods and observations, in deduction and in induction, by their training and work in other fields of science, a profession and a training that has given to this Society and to the world such men as J. Y. Simpson, who became a fellow in 1829; as Edward Forbes, who joined in 1831; as John Goodsir, as J. Hutton Balfour, as T. Spencer Cobbold, and a host of others whose names are familiar to all, could not allow these men to grope along tunnels of mere empiricism, if by the application of scientific methods there was any hope of obtaining a clearer light on the etiology, pathology, and treatment of disease.

One of your earlier presidents has said: "for though some think that such societies are for the exhibition of ingenious papers, or the mere unravelling of a piece of anatomy, there

is a far higher and more enduring object than that in the diffusion of a knowledge of natural history." The work of the Society is, in fact, first of all to accumulate facts of natural history, which, to adopt what was said of Cuvier's facts, "were brought together in such a manner as to make them tell the history of the world;" but these facts must be so collected, arranged, and sent out, that they may rouse the interest of minds which may ultimately so piece them together that this history of the world may be told. Our present work is to collect facts that may be ready for the advent of some great mind which may arrange them, and found new theories and generalisations from which new excursions may again be made.

For the present, although we should make our own the dictum of Dr J. A. Smith, who in his presidential address said, "we are men of work, not talk," I shall talk, as I find that in many of the past addresses the speaker has taken for the text of his discourse his own special subject, and although a discourse on pathology might prove somewhat uninteresting, I hope I may be allowed to avail myself of my privilege, and give a short account of some points in bacteriology and the relation of bacteria to disease, a subject not actually my own, but one in which I will try to give opinions rather than to state dogmatically my own work and results, as such a review, very naturally, must have a somewhat wider general interest for my hearers. I venture, therefore, to give a brief sketch of what is now occupying the minds not only of scientific men, but is moving to their utmost depths, and raising to extreme heights, the sympathies and hopes of those who are trying to help suffering humanity struck down by such fell diseases as small-pox, hydrophobia, and consumption. I shall not confine myself to one disease alone, as the principles of preventive and curative inoculation have a far wider foundation than that on which any one of the wonderful discoveries that have been made in recent years are based.

Scientific workers have gradually been accumulating facts, observations have succeeded observations, patient work and powerful concentration have played their part in elucidating

our knowledge of the habits of animals, the reproduction of cells, the conditions under which protoplasm may be stimulated, or its activity depressed. The organisms that are found in certain diseases have been classified, their modes of propagation and spread have been observed, and everything has been prepared for great epoch-making minds to come in and generalise on the facts that have been obtained, and to point out the gaps that still remain to be filled up before the theories founded can be proved to demonstration.

In France we have Davaine and Pasteur, who, assisted by Chauveau and others, have given to us the germ theory of disease, and the theories of fermentation and protective inoculation. In Germany, Klebs, Koch, and their pupils, have made marvellous contributions to the study of bacteria and their relation to disease; whilst in this country (despite the free criticism of recent writers) Lister's work in the domain of antiseptic surgery will make his name famous throughout all generations of surgeons, and if he had succeeded in achieving nothing but the extermination of the old methods of treating wounds, by which our hospitals were in many cases transformed into perfect forcing-houses for the growth of bacteria and septic organisms, he would have rendered a service to humanity the value of which cannot be expressed in terms that any but the most eloquent can call up at command.

I find, in going over the papers published in the *Proceedings* of the Society, that the first paper bearing on the subject of bacteria was introduced by Principal Williams on February 19, 1879, when he dealt with "Splenic Fever, with a Short History of the *Bacillus anthracis*." The subject was sufficiently interesting, but so little was generally known of it, that one can easily imagine that even the name of the *Bacillus anthracis* at that time (only a little more than eleven years ago) was familiar to scarcely a dozen members of the Society; whilst now, even the daily newspapers (than the editors of which none know better what the public require to interest them) contain long and accurate accounts of organisms which, though visible only under magnifying lenses of enormous power, have so real an existence in the

popular mind that they are readily recognised as being the potential causes of numerous diseases.

Let us for a few moments turn our attention to the history of these minute organisms. We are at once struck by the fact that even the earliest observers appear to have looked for the causation of disease in minute organic and organised beings, as they were convinced that the symptoms of disease could be produced only as the result of the action of living protoplasm; and we find in Kircher's "Pathologia Animata" the first attempt to evolve a parasitic theory of disease, which, imperfect as it was, foreshadowed the better-founded and more accurate theories which within the last thirty years have been so well put forward and so ably supported. The first authentic description of these organisms, however, was given, not in connection with disease processes, but with some of the common processes of everyday life. Leeuwenhoek in 1675, or four years after Kircher's book had been published, discovered in an infusion of pepper, in the intestinal canal of horses, flies, frogs, pigeons, fowls, and even in his own diarrhœa stools, small moving and living forms of such extreme minuteness that hitherto their very existence had escaped the notice of the most careful observers with the somewhat primitive lenses they then had at command. Eight years later this same observer described minute organisms in the material taken from the teeth, that we now recognise, from his descriptions and drawings, as bacteria. Of them he says:—"On reflecting on these substances, I thought it probable (though I could not observe any motion in it) that it might contain small living creatures. Having therefore mixed it with rain-water which I knew was perfectly pure, I found to my great surprise that it contained many small animalcules, the motions of which were very pleasant to behold. The largest sort of them is represented in plate v., fig. 3, at A [1] (evidently a somewhat spindle-shaped bacterial form or clostridium), and these had the greatest and the quickest motion, leaping about in the fluid like the fish called the jack: the number of these was very small. The second sort are represented at B (a shorter, plumper organism).

[1] Leeuwenhoek's Works, translated by Samuel Hoole, London, 1800.

These often had a kind of whirling motion, and sometimes moved in the direction represented by the dotted line CD (in curves and circles): these were more in number. Of the third sort I could not well ascertain the figure, for sometimes these seemed roundish or oblong, and sometimes perfectly round (bacterium or micrococcus): these were so small that they did not appear larger than represented at E. The motion of these little creatures one among another may be imagined like that of a great number of gnats or flies sporting in the air. From the appearance of these, to me, I judged that I saw some thousands of them in a portion of liquid no larger than a grain of sand, and this liquid consisted of 8 parts water and 1 part only of the before-mentioned substance taken from the teeth." Nine years later he gave a much fuller description, and also described organisms which were evidently spirilla with their characteristic movements, as he says that these organisms "move their bodies in comparatively marked curves, swam forwards or backwards, or twisted themselves in an extremely lively fashion." As was very natural, Kircher's "worms," as the *fons et origo mali*, were replaced by these wonderful little organisms described by Leeuwenhoek; and Nicolas Andry, putting Kircher's theory and Leeuwenhoek's observations together, evolved a germ theory, not only of disease, but of putrefaction and fermentation. He held that air, water, vinegar, fermenting wine, old beer, and sour milk were all full of germs; that germs were also contained in the blood and pustules of small-pox patients; in fact, these germs became so widely talked of that, as Loeffler points out, these inconceivable worms became the legitimate butts for the shafts of ridicule, and in 1726 there appeared in Paris a satirical work in which these small organisms received the name of "fainter," "body pincher," "ulcerator," "weeping fistula," "sensualist," and so on. So well was this done, and so ridiculous was the whole system made to appear by the satire that was directed against it, that it became completely discredited, and so for long was only mentioned to be ridiculed. Linnæus, however, with his wonderful powers of observation and deduction, became convinced that in these organisms might lie, not only the

actual contagium of certain eruptive diseases and of acute fevers, but also, as had been pointed out by Andry, the exciting causes of both fermentation and putrefaction.

Many attempts were made to classify the organisms that had made such a stir in the scientific world, and Müller of Copenhagen was at length able, about one hundred and four years ago, to reduce to scientific and systematic order what had hitherto been merely chaos.

Although it was held, even at this early period, that these organisms were the causes of fermentation and putrefaction, there were many differences of opinion as to how they were developed, whence they came, under what conditions they could live, and how they carried on their work. Whether they were the result of spontaneous generation, or were the progeny of pre-existing forms, was the question which for over a century occupied the minds of those engaged in scientific research and speculation. Some observers considered, though they had no great amount of evidence to adduce in support of their theory, that bacteria were the progeny of minute organisms which were present in myriads in the air, from which they were deposited on fruits, plants, and other matter, and whence they made their way into the various infusions prepared for them. In this country a prophet arose in the person of Dr Needham, who was really the first to suggest an attempted solution of the question by a theory of abiogenesis or spontaneous generation. Needham at first thought that these vibriones or "plant-animals," as he called them, arose from plants by special vegetative power, and that from the plant-animals, by a process of evolutionary accretions, other organisms again arose. He tried to prove, by boiling a beef infusion and then keeping it and allowing it to putrefy in a well-stoppered bottle (a most scientific method), that these zoophytes could not owe their origin to germs which outside insects or organisms had brought into the infusion, as he considered that the boiling should have destroyed the germs originally in the fluid; and as no new germs could, he thought, make their way into the closely-stoppered vessel, the resulting organisms must be the result of the action of a special vegetative force. To very critical

minds it appeared, however, that these experiments of Needham's left loopholes for other explanations than those which he had given, and Bonnet, of Geneva, suggested that the vessels used by Needham were not hermetically sealed; that an almost invisible opening would be quite sufficient to serve as a means of entrance to organisms so minute as those with which he was dealing; and that, on the other hand, there was a possibility that the germs were so far resistant to increase of temperature that they might live through a short period (a few minutes only) of treatment with boiling water. Abbot Spallanzani followed up, by his wonderful experiments, the theoretical criticism of Bonnet. After convincing himself that organisms did actually develop in unboiled infusions, even when the outer air was rigorously excluded, he argued that the germs or eggs, as he termed them, of micro-organisms might exist on the walls of the vessel, on the material of which the infusion was made, or suspended in the air within the vessel. To get rid of these germs from the vessels, he heated the latter over the fire, then filling them rapidly with his infusions, he allowed them to cool, and sealed them hermetically. He still found, however, that after a few days a number of organisms made their appearance. Could the organisms have got in along with the air during the process of cooling?

To set this question at rest, he made a number of infusions in hermetically-sealed flasks, and boiled them for a whole hour, with the result that in flasks so treated no organisms or traces of their activity could be found; if, however, the sealing was in any way interfered with, organisms soon made their appearance. From these experiments he concluded that living germs were necessary for the development of putrefactive organisms. This fact once established, the whole question was much simplified, and the principle on which it rested was soon utilised in Paris and elsewhere in the methods adopted for ensuring the preservation of various food-stuffs—methods which, with few modifications, have been handed down to the present day. It was, of course, objected that Spallanzani had shut out air, and therefore oxygen, from his vessels; or that he had so altered the

constitution of the air which still remained that it was not possible for these minute organisms to develop or flourish in it. This objection was met in 1836 by F. Schulze, who put the question to himself, "Whether the access of atmosphere, light, and heat to substances in flasks included of itself all the conditions necessary for the primary formation of animal or vegetable organisms?" To prove that this was not the case, Spallanzani's conditions of absolute freedom from germs capable of development in the infusion must be obtained; and, secondly, air perfectly free from germs must be admitted to this infusion in considerable quantities. Schulze proceeded as follows:—He filled a flask half full of distilled water, to which he added various animal and vegetable substances. He gives the following description of the further methods of procedure:—"I then closed it with a good cork, through which I passed two glass tubes bent at right angles, the whole being air-tight; it was next placed in a sand-bath and heated until the water boiled, and thus all parts had reached the temperature of 212° F. While the watery vapour was escaping by the glass tubes, I fastened, at each end, an apparatus which chemists employ for collecting carbonic acid gas; that on the left was filled with concentrated sulphuric acid, and the other with a solution of potash. By means of the boiling heat employed, every living organism and all germs in the flask or in the tubes were destroyed, and all access was cut off by the sulphuric acid on the one side and by the potash on the other. I placed this easily-removed apparatus before my window, where it was exposed to the action of light, and also—as I performed my experiments during the summer—to that of heat. At the same time I placed near it an open vessel, with the same substances that had been introduced into the flask, having also subjected them to the boiling temperature. In order now to renew constantly the air within the flask, I sucked with my mouth several times a day the open end of the apparatus filled with a solution of potash, by which process the air entered my mouth from the flask through the caustic liquid, and the atmosphere entered the flask from without through the sulphuric acid. The air was, of course, not at

all altered in its composition by passing through the sulphuric acid in the flask; but if sufficient time was allowed for the passage, the portions of living matter, or matter capable of becoming animated, were taken up by the acid and destroyed. From May 28th till the beginning of August I continued uninterruptedly the renewal of the air in the flask, without being able, without the aid of a microscope, to perceive any living animal or vegetable substance, although during the whole of that time I made my observations almost daily on the edge of the liquid; and when at last I separated the different parts of the apparatus, I could not find in the whole liquid the slightest trace of infusoria, confervæ, or of moulds; but all three presented themselves in great abundance a few days after I had left the flask standing open. The vessel which I placed near the apparatus contained on the following day vibriones and monads, to which were soon added larger polygastria, infusoria, and afterwards rotatoria."

Schulze was thus able to prove that the sterility was not dependent upon any alteration in the air within the flask, or to the small quantity of air contained in it, and that it was not due to any alteration brought about in the liquid by the heating process, as on the one hand a large quantity of air was passing through the flask, whilst on the other the fluid that had been boiled, but which was left exposed, rapidly underwent decomposition, a decomposition that was accompanied by the development of micro-organisms in very large numbers.

The objection that some particles of sulphuric acid drawn in with the air might affect the growth of organisms was met by Schulze by further experiments; and Schwann, who, instead of using sulphuric acid, used heat as a means of destroying any particles that might be present in the air that was drawn into the flask, corroborated Schulze's statements. Now came further objections from the supporters of abiogenesis, who stated most definitely and categorically that these workers were not dealing with germs at all, but simply with particles of albuminoid matter floating in the atmosphere, as a result of the vegetative power of which, organisms of various kinds, according to the conditions by

which these particles found themselves surrounded, were caused to be developed. Only thirty-seven years ago, Schroeder and Von Dusch demonstrated an even simpler method of depriving the air of its organisms; they found that air filtered through a layer of cotton wadding was sufficient to render it incapable of producing decomposition in infusions from which the germs had already been eliminated by heat. Then five or six years later Hoffmann, Chevreuil, and Pasteur pointed out that if the narrow neck of a bottle in which the germ-free infusion was contained was bent downwards, and no strong currents of air were allowed to pass from without into the flask, any germ-free fluid contained within could undergo no putrefactive changes; and they argued that germs, like all other solid particles, are amenable to the laws of gravitation, and that when they are not carried about by currents they must settle down upon an upper surface, and that for this reason, when the mouth of the neck of the bottle was bent downwards, no organisms could find their way into the bottle. Tyndall gave demonstrative proof of this in his exquisite experiments of smearing the inside of a chamber with glass walls with glycerine which retained all particles as they fell. After proving their entire absence by passing through the chamber a ray of light which could only be seen so long as particles remained suspended in the atmosphere, he placed vegetable infusions which had been sterilised by heat within, with the result that they remained free from any trace of any organic life for several weeks together. The battle between the adherents of abiogenesis and biogenesis was one of the most interesting controversies, and one in which more ingenuity was developed than in almost any other that had raged for some time. As we know, the battle went in favour of those who did not believe in spontaneous generation, and the matter has now been definitely set at rest. It is an accepted belief that bacteria, or microbes, as these lowly organised forms are now called, may be destroyed by heat and by certain chemical reagents, that when once destroyed in any media no other organisms can rise from their ashes, and that such media remain perfectly free from putrefactive changes until fresh germs are introduced from without.

The triumphs of surgery, of preventive inoculation, of hygiene in relation to specific infective disease, of preservation of food, have all had their origin in the knowledge gained during the battle which waged around the theory of spontaneous generation or *generatio equivoca,* and although this was ultimately proved to be untenable, those who fought so vigorously for it came out of the contest defeated, no doubt, but not disgraced, for we owe to them and to their attitude of scepticism, and to the free, ingenious, and honest criticism which they passed on imperfectly conducted experiments, and on vague and inadequately supported theories, the fact that the experiments of their opponents gradually became not only more convincing, but ultimately were perfected; and if to-day we have reliable methods of sterilisation and of obtaining pure cultivations of different organisms, it is because nothing was taken for granted, because able men were found to take sides in this controversy, and to engage in a fight that was fought out to the death.

Gentlemen, I will not weary you with a long description of what these micro-organisms are, nor will I enter into the oft told story of the development of the germ theory of putrefaction and fermentation and of disease; I would only have you remember that an enormous amount of work has been done to prove that bacteria belong to the animal kingdom. It may now, however, be generally accepted that they are to be transferred to the domain of the botanist. We must remember, however, that they are of a low form of protoplasm, and that although in certain cases they may be considered as having special functions, the general powers of protoplasm are most strongly developed in them, and that their specific powers are more readily affected than where development is of a higher order.

A patient accumulation of facts at length made it possible to build up a theory that would stand the test of time and experiment, and it became easy to prove, by the use of new methods, what was at first only a theory, and, by the carrying on of fresh experiments, to fill in the gaps that were still left.

As early as 1814, Dr Burrows, in this country, had

intimated that in putrefying fish there was a poison which he had been able to separate, and which probably, he thought, was formed as the result of the action of the minute organisms that were found in the putrefying mass, feeding on the albuminoid materials of which the fish was composed. Panum, the professor of physiology in the university of Copenhagen, corroborated Burrow's observations from an independent standpoint, and in 1856 gave to the world his experiments on sepsine, a substance that resulted from a putrefactive process, and that gave rise to symptoms of septic poisoning. From that time forward, through the labours of Selmi in Italy, of Gautier, Bouchard, and others in France, of Brieger in Germany, and of numerous other minor workers, we have been supplied with many facts relating to the physiological action of these poisons. From the nature and physiological peculiarities of these substances, it was at first supposed that the ptomaines or cadaveric alkaloids resembled the vegetable alkaloids which had previously been described, but on attempting to separate them by the various alkaloidal processes, it was found that whilst many of the most poisonous ptomaines could not be separated by the ordinary methods, and did not give even the alkaloidal reactions, certain substances which are known to have no relation to alkaloids are found to give the so-called characteristic reactions, so that further search had to be made into the composition of these ptomaines.

Our knowledge of these substances has been gradually extended. We know that some are poisonous, that others are non-poisonous, that even in the products of putrefaction the same holds good. We now know that they are derived from nitrogenous material, that they are, in fact, the result of the action of bacteria on animal or vegetable albuminoid material, that they are basic in character, that there are frequently only minute differences in their composition, and that they are very unstable, readily undergoing oxidation, and that the only means by which these unstable substances can be examined and preserved is by rendering them stable, and by making them enter into combination with certain substances, such as the chlorides of mercury, platinum and gold, picric

acid, or benzoyl chloride, with all of which more stable compounds of the ptomaines are formed.

It was further found that Pasteur's observations as regards fermentation could be applied to the formation of these ptomaines, and it was found that, just as in the case of brewing of beer, it was not only the food substance that determined the nature of the ptomaine formed, but also the kind of micro-organism that grew in the food. Thus whilst some yeasts would give rise to the pure alcoholic fermentation, others gave rise to a bitter taste in the beer, whilst some organisms again give rise to butyric fermentation, and others produce lactic acid. It thus became possible to understand how certain diseases could be produced by the vegetative activity of the organism in the body giving rise to the formation of poison which could so far paralyse the protoplasm of the cells that the organisms were allowed free play to develop and ultimately overcome their host. This, however, proved the stepping-stone to the rationale of preventive inoculation, and however these preventative inoculations may be ultimately explained in different cases, and there are many various theories as to how this occurs, we may confidently anticipate that we are now on the eve of a general system of inoculation against the specific infective diseases, diseases that have hitherto proved intractable to the treatment of both physician and surgeon.

We have before us a period in which controversy as to the action of micro-organisms in the body, and the various methods of combating these, will be most thoroughly discussed and experimented upon, and we may safely prophesy that during the next few years certain departments of prophylactic and hygienic medicine will be entirely revolutionised. At present the methods of treating patients suffering from, or liable to suffer from, micro-organisms through their accidental introduction, may be divided into four, and it may be well here to formulate briefly the essential points of these various methods. In the first of these, as an example of which may be taken inoculation against anthrax or small-pox, we seek, by introducing a modified poison, or minute doses of the virulent poison, to habituate or acclimatise the cells and

tissues of the body to the action of the specific poison. In the first instance we give this poison in such small doses that the protoplasm of the cell, in place of being depressed, is stimulated. We try to repeat here what Lister did in the case of cilia, stimulating or over-stimulating by a hot wire, gradually approached nearer and nearer to the active protoplasm; when some little distance away, the protoplasm was stimulated, and the cilia were more active, but when approached still nearer the cell protoplasm was over-stimulated or depressed, and the movements of the cilia became slower, and finally stopped. A strong dose of the poison, then, in the same way may depress the cells, but a weaker dose may stimulate into greater activity, and so enable them to resist a future stronger dose more readily. By this method the protoplasm is altered in its resistant power so gradually that, ultimately, it may be enabled to withstand a very considerable dose of the poison. It is, in fact, by a single operation, or more usually by repeated inoculations of the poison in doses of gradually increasing strength, at length able to withstand the action of considerable doses of the most virulent poison, of doses as large as can be introduced under any ordinary circumstances. In this connection, however, it must be remembered that no tissues or animals can be absolutely protected against the action of these virulent poisons. This is what we should expect.

As regards this acquired immunity, we have still to learn whether it is due to a general increased activity of the cells, or to the production of specific powers and products by these cells under the modified conditions in which they exist and carry on their functions after inoculation. Ingenious arguments are brought forward on both sides, Metschnikoff maintaining that the cells themselves are the main factors in the destruction of micro-organisms and their products, whilst others, especially those in the German school, maintain that the germicidal power rests in the fluids in which the cells are bathed, and that the cells can only play the part of scavengers in removing dead material. Which of the two schools will ultimately triumph—the phagocyte theory school or the protective soluble poison school—it is difficult to say.

Both are busy building up theories; but, better still, both are collecting facts, and from an impartial examination of the work done in the two camps, it appears to be probable that ultimately they will be drawn closer and closer together until they actually unite. Secondly, we have what has been described as the antidotal method of treatment, in which it is supposed that one poison may be made to interfere with the action of another. For instance, the soluble products of the organism which is found in blue pus (the *Bacillus pyocyaneus*), if injected systematically, protects an animal against a considerable dose of anthrax. How this acts it is difficult to say, but we appear to have evidence that an antidotal action between the blue pus material and the anthrax poison may be exerted. The third method is that in which we attempt to kill the organisms outright in the system; but so far as we can make out at present it is impossible to achieve this without the assistance of the living cells of the body, as any substances which are capable of killing the organism, when introduced in sufficient strength into the fluids of the body, unless they have a specific action, would also kill the cells of which the tissues are composed, so that for the present this method need not be very seriously considered, until further laboratory experiments have been conducted.

Within the last few days, as the outcome of Koch's patient work, there has been added to this number a fourth method of treatment of diseases associated with the presence of micro-organisms. He goes on the plan of depriving the micro-organisms of their pabulum, and so practically starves them to death, in place of killing them off directly. As this is a question of considerable interest at the present moment, let us see what is the basis on which Koch is working. To begin with, it is to be understood that the tubercle vaccine prepared by Koch is not capable of performing all that has been claimed for it by too ardent disciples, and even Koch himself distinctly warns those suffering from phthisis that they must not raise to too high a point their hopes of being benefited by it. We must assume from the nature of tuberculous disease, even accepting his

statement that he has been able to obtain a substance which, when injected into the human subject, brings about disintegration or degeneration of any tissue that forms a nidus for the tubercle bacillus, that it is impossible to restore lost tissues, although by Koch's treatment we may be able to localise the diseased patches. Here the success of the treatment is supposed to depend, not upon the fact that the tissues of the patient become accustomed to the action of the poison produced by the tubercle bacillus (though it is possible that even this may play a part in the process of cure), but rather to the fact that the diseased area is so sharply defined by the reaction set up on the introduction of the lymph that the tuberculous mass becomes encapsuled; the bacilli are confined to this area; they gradually use up the pabulum that it contains, die of starvation, and eventually may be removed along with the rest of the dead tissues.

If all this be true, the era of surgical interference with tuberculous masses may be said to have dawned, especially should it be found on further experience that the separation of the dead from the living tissues is as distinctly brought about as Koch assumes. Up to the present, the treatment has been most successful in cases of lupus, a tuberculous disease of the skin, and Koch has not the slightest doubt as to the ultimate success of his treatment in this class of cases. After weekly injections for three or four weeks of full doses of the lymph, introduced at some distance (usually in the back) from the ulcerating surface, the disease appears to be cured, and cicatrisation or scar formation takes place, even where the disease has been of several years' standing. From the nature of the changes that take place in lupus, we may assume that the lymph acts immediately on the tubercular granulation tissue, of which the surface of the ulcer is composed; the lupus spots become red, and begin to swell, showing that there is an increase of fluid in the blood-vessels, and probably also in the lymph spaces. This commences before the rigor or shivering, which is a characteristic feature in tubercular cases, sets in. During the fever that follows, the swelling and redness increase, and finally become so marked that small brownish spots of dead tissue are for

as a result of the intense reaction—the tissues apparently dying before the eyes of the observer. In those cases where the lupus is sharply defined, the central portion corresponding to the tubercular granulation tissue becomes swollen and brownish, and eventually dies. Surrounding this centre is a whitish rim, almost a centimetre wide, the exact nature of which is not evident, though we may expect to find that it consists of an odematous connective-tissue area; whilst outside again is a broad band of bright red inflammatory tissue (corresponding to the old hyperæmic zone), in which there appears to be, from all accounts as yet received, an attempt made by the healthy tissues to still further localise the mischief. Should a similar series of changes take place in the tubercular areas of bones and joints, the question of operation—after the injection of the lymph has done its work—will of course be settled, and the same will apply to glands or other tubercular tissues that are accessible to the surgeon's knife. Indeed, with the present facilities that we have for carrying on cranial and abdominal surgical operations, we can quite see that, in the event of Koch's observations being confirmed, there can be almost no limit to the application of surgical interference in such cases; for as it is pointed out by eminent surgeons, it will not be a very difficult matter to remove from the lung a localised mass of tubercle, or a series of masses, even in those cases when drainage of tuberculous cavities would be out of the question.

Before allowing ourselves to be carried away by too great enthusiasm concerning what is undoubtedly a marvellous discovery, we must, in addition to the facts mentioned above, bear in mind that Koch himself has insisted that the reason no tubercle bacilli can in many cases be demonstrated in caseous areas is, that as soon as the conditions have become somewhat unfavourable to the existence of the bacillus, spores are formed, and these remaining (although undemonstrable) in the caseous mass, may prove a fruitful source of infection for long periods after the bacilli themselves have disappeared. It is for this reason that the danger of removing uberculous masses by scraping and cutting has hitherto been sisted upon. If this danger be present in the normal course

of tuberculosis, the same will apply to those cases in which, by Koch's treatment, we may succeed in localising the tuberculous process. Two difficulties present themselves, which doubtless in time, however, will be removed, but which at present deserve our most careful attention. It will be necessary to make sure that the process of death, localisation, and separation of the dead mass are complete, and even when this is the case, the greatest care will have to be exercised in the removal of these necrosed masses, so that the sequestrum and its contents may be disturbed as little as possible. Free but careful incision will have to be the rule in dealing with these dead and separated tuberculous masses; and it is probable that in making these incisions the thermo-cautery may be called into greater and greater requisition. What, too, if the localisation is not complete, or if the healthier tissues will not react to the specific poison, or if they are over-stimulated, will there not be greater danger than before of the tubercle spreading?

It would be idle with the data at our disposal to attempt to discuss the nature of the lymph, but, so far as we can see, it is some preparation of the secretions of the tubercle bacillus, considerable support being given to this view by the fact that the local and constitutional reactions are not set up in other cases where we have granulation tissue somewhat similar to tuberculous tissues, as in syphilis for example, from which we must assume that the lymph does not necessarily act on all tissues of low vitality. Koch's lymph, acting in conjunction with the products of the tubercle bacilli in the body in the bringing about of rapid disintegration of the cells amongst which they lie, is probably of the same nature as the poison developed in the body, compelling the activity of the tubercle poison to be exerted at once on the cellular tissues, probably by a kind of cumulative effect, so as not to allow of its being transferred by lymphatic or other channels even of those tissues in the immediate neighbourhood of the sequestrum. It may be that, acting on the healthy tissues, it assists in setting up rapid localised reactionary changes, by which are brought up a sufficient number of active cells and fluids to deal with any bacilli th

may escape, or with any poisons that have not been compelled to act in the caseating area, and to give rise to a quantity of new fibro-connective tissue, which may form a localising zone —*i.e.*, just as in the case of tubercle undergoing healing under normal condition. All this points, as I have said, to the fact that Koch is dealing with a soluble poison very similar in nature and composition to that set free by the tubercle bacillus itself.[1]

The chemical side of bacteriology is rapidly becoming one of the important questions of the day; Roux and Yersin's work on the diphtheria poison, which they have been able to separate from cultures of the diphtheria organism, and even from the membranes of the throat in which the organism has been developed, is a substance which they compare to an enzyme. Similar researches have been made on the tetanus poison, from which it is proved that the poison here is also of the nature of an enzyme, and that its virulence is very great, and the recent work on the albumoses and their effects in stimulating the cells of the body, and interfering with the development of organic poisons, might occupy this Society, and probably will occupy some of its members, for years to come. This, also, though a most fascinating subject, must be left for the present.

We have been engaged so long and so closely in the study of vegetable micro-organisms, that those on the other side of the border-land, the animal micro-organisms, are in danger of being overlooked, but more light is daily being thrown on the action of these latter organisms, and by a process of elimination we have been led to think that in those diseases in which it has been found difficult or impossible to separate vegetable micro-organisms, and assign to them a causal relation to such diseases, psorozoa or psorospermæ may play a part. The coccidia or micro-sporidia described by Pasteur in pebrine, or silkworm disease, the beautiful organism found in the blood in certain stages of malarial attacks, the psorosperms

[1] Since this was read Koch has made known the composition of his lymph, and has added many new facts to our knowledge of its action, but the above description, though founded on imperfect data, may still be held as essentially accurate.

found in snails, in the bladders of fishes, in the vesicles of herpes or shingles growing in the epithelial cells, in Paget's disease of the nipple, in the livers of many rabbits, and in the proliferating cells of epithelioma, in *molluscum fibrosum contagasiosum,* and in a multitude of other conditions, show that these animal micro-organisms are associated with disease, and from what we know of vegetable organisms we must assume that in some cases at any rate they are the *causæ causantes* of the disease. It does not require a great stretch of the imagination to see that protoplasm is protoplasm, whether it be animal or vegetable. We know that all cells feed, grow, multiply, secrete and excrete, that the most minute differences in appearance, in structure, and in composition, are accompanied by marked differences of vital manifestations, but we also know that cells which appear to be placed at extremes from one another, of cell life and structure, may give rise to phenomena which, with the methods at our disposal, we cannot discriminate one from another; and we cannot therefore assume that the presence of these parasitic animal protoplasmic masses are merely accidental in any disease, though until we have proved their relations as causal agents to the disease, we must not be satisfied to accept them as such; let us apply to them the same searching tests that we have applied to vegetable micro-organisms, and as we continue to improve our methods of dealing with the latter, let us build up methods for elucidating the mysteries connected with the former.

With all this, let it be remembered that there are all kinds of modified theories of disease, of immunity, and of vaccination, that as yet we are dealing with isolated facts rather than with well-founded theories, and that it is our duty, though adding to the volume of facts, to keep an open mind as to their explanation. I do not wish for one single moment to discourage the seeking of explanations of facts and by facts, but I do wish to accentuate, as far as possible, the necessity that there is for us to set our faces against the building up of complicated theories on utterly inadequate foundation. We may rest assured that error will gradually be eliminated, facts will be sifted and rearranged, and new coigns of vantage

will be won, from which workers who are fighting with disease may advance to make fresh conquests. Truth is truth whether it accords with our theories or routs them. Let every man amongst us strive to attack the problems set before him in an earnest and truth-loving spirit; let us be careful at all times not to go beyond our facts, but should we find that we have been led into error, let us be the first to acknowledge it; let all controversies be carried on in an impersonal spirit; let each man look upon his brother worker as a friend working in a common cause, anxious for the light of truth to be thrown on all his work; and let us be more ready to receive criticism than to give it. We are all acquainted with the basis on which we build up our own theories, but we are not always cognisant of the facts on which our neighbour maintains his tenets and beliefs; had we his light we might have his belief also.

Whatever may be said of the medical members of a society which has gathered into its fold scientific men of every condition and degree, it must be admitted that they have always been among the first to utilise for their beloved profession, and in the interest of the healing art, in which all men are so doubly interested, every scientific factor that has been placed before them by the brilliant workers in this and in other societies. That they have been hampered in their researches by the very people who twitted them with the fact that they are non-scientific is undoubtedly true, but empiricism in the evil sense of the word has little footing in the training of our students, and I maintain that we have ample proof of the truth of this in the recent marvellous discoveries in the regions of preventive medicine and physiological treatment.

I. *Notes on the Petrels of Madeira and adjoining Seas.* By J. J. DALGLEISH, Esq., M.B.O.U.

(Read 18th February 1891.)

In the course of an inquiry into the status of the Petrels frequenting the Madeiran Seas as breeding species there, I have recently received specimens of the following, all of which, except *Œstrelata mollis,* have actually been found breeding on one or other of the small islands which adjoin and belong to Madeira, none having been known to nest on the main island. These small dependencies form two groups, one named Porto Santo, which includes several smaller islands lying off it, and the other the Desertas islands. Porto Santo is of considerable size, supporting a population of about 1800, growing grain and vines, and lies to the north-east of Madeira. Its highest point is about 1650 feet above sea-level. Of its satellites, the three largest are Ilho de Cal, Ilho de Ferro, and Ilho de Cima. Ilho de Ferro contains lime quarries, the stone from which is largely used for building purposes in Funchal. The Desertas lie to the south-east of Madeira, about ten miles from the nearest point of land. They are uninhabited save by goats, rabbits, and birds. They consist of a chain of three islands, the largest, Deserta Grande, in the centre; the other two, Chao and Bugio, lying off either end, their whole extent being over twelve miles in length. They are visible from Funchal, and form fine objects in the view from that place. All of them are very precipitous and rocky, and the landing is difficult and at times impossible. Deserta Grande rises to a height of 1600 feet, and is six miles long by one mile in breadth. It is bare, with the exception of two clumps of stone pine in the centre of the island; on the east side is a cave, frequented by the Mediterranean seal, *Monachus albiventris.* Bugio is four and a half miles long by half a mile wide at its widest part, but in the centre it is very narrow. It is upwards of 1350 feet in height. Chao, the nearest of the group to Madeira, is barely a mile long, and the highest point only reaches to 336 feet. It is flat on the top. All three islands are visited from time to time for the Orchilla lichen and barilla, which yield a small return to the

proprietor. The specimens undernoted were all obtained upon one or other of the islands of the two groups above alluded to, and all of the species to which they belong may be considered as permanent residents except *Œstrelata mollis*, which, until more evidence is forthcoming, can only be considered a straggler. I have added the native or Portuguese names.

1. *Puffinus kuhli* ("Cagarra"), the Mediterranean Shearwater.—This species has frequently been recorded from Madeira as *Puffinus major*, whose breeding haunts are not as yet certainly known. *Puffinus kuhli* is very common in the Mediterranean, and breeds on many rocky islands there, including Gozo, off Malta. Godman found it breeding in the Azores, and it doubtless breeds also in the Canary Islands. On the Selvages, a group lying between Madeira and the Canary Islands, it is found in great numbers, and the fishermen salt them for food, sometimes as many as twenty thousand Shearwaters being taken in a season, a few only of this number being *P. anglorum.*

One specimen, Bugio, Desertas, July 1889.

One egg, Deserta Grande, 17th March 1889.

2. *Puffinus obscurus* ("Pintainho"), the Dusky Shearwater, is found on both sides of the Atlantic, and breeds in the Bermudas and Bahamas, and in 1888 was found nesting also in the West India Islands of Barbadoes and Grenada by Colonel Feilden and Mr Wells respectively. On this side, Mr Godman found it in the Canaries, where he believed it to breed. Vernon Harcourt obtained eggs on the Desertas. It much resembles the Manx Shearwater, except in its smaller size. It is said to breed earlier at Porto Santo than on the Desertas. No eggs of this species were sent.

One specimen, Ilho de Cal, Porto Santo, July 1889.

One specimen, Bugio, Desertas, August 1889.

3. *Puffinus anglorum* ("Boiero"), Manx Shearwater.—Only an egg of this species was sent, but it is not uncommon in the neighbourhood of Madeira and the Canaries, and Godman found it nesting on the Azores. It is also found on the Selvages Islands.

One egg, Bugio, Desertas, August 1889.

4. *Bulweria columbina* ("Anguiho"), Bulwer's Petrel, named after a Mr Bulwer, long a resident in Madeira, is not

known to breed elsewhere than in the Madeiran islands and the Canaries. The first eggs received in this country were forwarded to Dr Frere of London, about 1850, and Mr Hurrell took a number in 1851 both from the Desertas; while still later Godman found eggs on Chao, one of that group. In 1889 Meade Waldo found it breeding near Orotava, in the Canary Islands. Bulwer's Petrel has hitherto been recorded as confined to the Eastern Atlantic, but has occurred in Greenland and Bermuda; and Stejneger, in the *Proceedings U.S. Museum* (xii., 378), assigns to this species two specimens received from the Hawaiian Islands, in the Pacific, in 1889.

One specimen, Ilho de Cal, Porto Santo, July 1889.

One egg, Ilho de Cal, Porto Santo, May 1889.

Three eggs, Bugio, Desertas, July 1889.

5. *Procellaria leucorrhoa* ("Roque de Castro"), Leach's Petrel, at one time considered more an American species, has of late been found nesting on several stations on this side of the Atlantic. First observed in St Kilda by the late Sir William Milner, it has lately been found breeding in North Rona by Mr John Swinburne, one of our fellows, and in small numbers on the Blasquet and Skellig islands, off the coast of Kerry, in Ireland, by Mr Ussher. I have been unable to discover a previous record of its breeding on any of the West African islands, although Mr Vernon Harcourt has stated that it reaches Madeira.

One specimen, Bugio, Desertas, August 1889.

One egg, Bugio, Desertas, August 1889.

6. *Œstrelata mollis,* Soft-plumaged Petrel.—This species described by Gould from Australia, is also found in the neighbourhood of New Zealand and the Cape of Good Hope. I am not aware that it has been found breeding elsewhere than in New Caledonia, where Layard states that it nests near the summit of Mont Mou in that island. It has, however, previously occurred in Madeira, and there are, as Mr Salvin has informed me, two specimens in the museum at Cambridge, presented about thirty-five years ago by Dr Frere, who obtained them with other species of petrels from his correspondent in Madeira. Such being the case, and considering our scanty knowledge of the distribution of ocean birds, it is by no means improbable that a breeding place may yet be

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discovered on one or other of the West African islands. The single specimen sent was obtained on Ilho de Cal, Porto Santo, in July 1889, and I understand two others have since been obtained, one on Deserta Grande in the spring of 1890, which is now in the collection of Father Schmitz of Funchal, and the other in the present year (1891), which is now in the possession of Mr C. J. Cossart of Funchal. Besides the above, the following three species have been observed off Madeira and the Canary Islands.

Procellaria pelagica, the Stormy Petrel, is recorded from the Canaries by Bolle, and from Madeira by Vernon Harcourt.

Oceanites oceanicus, Wilson's Petrel, is said by Godman to be not uncommon off the Azores, where he thinks it may possibly breed. Meade Waldo observed it on Teneriffe. Wilson's Petrel was found breeding in Kerguelen by the Transit of Venus Expedition. It frequents both the Atlantic and Pacific Oceans.

Oceanites marinus, Whitefaced Petrel.—Canon Tristram believes he observed this species off Madeira, and Messrs Reid and Meade Waldo each obtained a specimen in the Canary Islands. The latter gentleman writes me later that he has obtained specimens from holes in the Canaries this season (1891), and thinks that it may yet be found to breed there. It is common on the coast of New Zealand, where it breeds.

In connection with this subject, reference may be made to the paper in our *Proceedings*[1] by the late Mr S. Swinburne on birds observed by him on voyages to the Cape of Good Hope.

II. *The Pearl Molluscs of the Persian Gulf.* By A. GALLETLY, of the Edinburgh Museum of Science and Art.

(Read 18th February 1891.)

[ABSTRACT.]

This communication was brought before the Society with the object of correcting the statement made about the pearl-oyster in all books giving an account of pearls, with the

[1] Vol. ix., p. 193.

exception of Mr Streeter's work on "Pearls and Pearling Life," published in 1886, in which he puts the matter more nearly in accordance with the actual facts. All previous writers about the pearl have called the *Avicula* (*Meleagrina*) *margaritifera* the pearl-oyster, and have left it to be inferred that this is the only pearl-yielding mollusc of any importance. Mr Streeter says that the finest pearls are got from it, but that they are not numerous, and adds that the largest quantity of medium-sized pearls are obtained from *Meleagrina fucata*, which he calls the pearl-oyster.

A short time ago a firm of merchants (Messrs Gray, Dawes, & Co.), who have been for many years exporting various products from the Persian Gulf—among them pearls and pearl shells—sent a number of specimens of shells of the molluscs fished for in the Gulf to the Museum of Science and Art in Edinburgh. These are distinguished commercially as five kinds, but in reality there are only three species, Mr Edgar A. Smith, of the British Museum, having kindly examined and named them. Their native and scientific names are:—

"Sadafi," or mother-of-pearl shells, . . .	*Avicula* (*Meleagrina*) *margaritifera.*
"Zinneo," mussel shell, large and small, . . .	*Avicula macroptera.*
"Mahar," oyster shell, large and small, . . .	*Avicula* (*Meleagrina*) *fucata.*

In the notes sent from Bushire along with the specimens, it is stated that both "Zinneo" (*Avicula macroptera*) and "Mahar" (*A. fucata*) are fished for pearls, but that the finest of these are obtained from the latter. No mention is made of *Avicula* (*Meleagrina*) *margaritifera* yielding pearls at all, although no doubt some will be occasionally got from it. The "Zinneo" shells being large and thick, are valuable for their mother-of-pearl, and the *Avicula margaritifera* is more valuable in this respect, being known as the mother-of-pearl shell. The "Mahar" (*A. fucata*) shells are of comparatively little value.

III. *On the Biological Examination of Water and Milk with special reference to Typhoid Fever.* By G. CARRINGTON PURVIS, M.D., B.Sc. Edin.

(Read 18th March 1891.)

Not many years ago the examination of water, air, or soil, in so far as the search and isolation of germs of disease were concerned, was a thing unknown, indeed the fact of living bodies being in any way the cause of disease was called in question; but, thanks to the labours of Pasteur, Lister, Koch, and others, there is not now the shadow of a doubt, that some at least of the deadly diseases are due to the presence of a living germ or parasite within the animal body. Take, for instance, that very fatal disease known as wool-sorter's disease or anthrax; this was shown years ago by Pasteur to be due to a microscopic organism or microbe known as the *Bacillus anthracis,* or again that very common disease known as phthisis, or pulmonary consumption (with which we are all more or less familiar). This disease was shown, by the beautiful researches of Koch, to be due to a very minute organism known as the *Bacillus tuberculosis,* or tubercle bacillus. Both these diseases—anthrax and tuberculosis—can be artificially reproduced in animals by the inoculation of the smallest portion of the living colonies grown outside the body, it may be, for several generations, and thus the cause of these two diseases is experimentally demonstrated; and by the same method of inoculation, accidental or otherwise, a few other micro-organisms, *e.g.,* bacilli of glanders, have been proved to produce disease in man and the lower animals.

When, however, we come to consider typhoid fever, cholera, and other diseases to which the lower animals are not, as a rule, susceptible, the question of a particular organism causing a particular disease is open to doubt, for in these diseases the direct or experimental method of demonstration by inoculation fails. If, however, a particular organism is always associated with a particular disease, and is not met with in any other disease, then there can be only three alternative explanations,—either the organism is the cause of the disease,

or it is the effect or the concomitant of that particular disease. In any case the value of a biological examination is not in the least impaired; if the presence of a particular organism is demonstrated, the previous existence of the disease, whether we look upon the organism as the cause concomitant, or the effect of that particular disease, is also demonstrated.

The special organism or microbe which is considered to be the *cause* of typhoid fever was discovered by Klebs, Eberth, and Koch almost simultaneously in 1880. This organism—known as Eberth's bacillus, or the bacillus of typhoid fever—is found in the viscera (intestines, Peyer's patches, spleen, mesenteric glands, etc.) of patients who have died of the disease, and it is from the spleen that "pure" cultivations of the bacillus are most easily obtained. The organism is also found in the excreta of typhoid patients, but here it is, as one would naturally expect, commingled with a host of other micro-organisms, and therefore difficult to isolate.

When, however, the bacillus has been isolated—by methods which I shall describe immediately—it can be cultivated artificially in various nutrient media, exhibiting characteristic modes of growth visible to the naked eye. These macroscopic, or naked-eye, appearances are of such vast diagnostic importance in connection with the study of micro-organisms, that I may be excused for referring briefly to the mode of growth of the typhoid germ in two very commonly employed and easily prepared media.

1. *Nutrient Gelatine.*—If a sterilised platinum needle be charged with a very minute portion of the organism in question, and the needle thrust into a tube containing sterilised nutrient gelatine, in the course of a day or two, at a temperature of about 65° F., a distinct whitish growth becomes visible along the track of the needle, and shortly after rounded or ovoid "colonies" are found to make their appearance along the side of the needle track. On the free surface of the gelatine a growth also takes place, but the border or edge of the growth, instead of being even, as is the case with most micro-organisms, assumes sooner or later a somewhat sinuous outline. At no time do the colonies ever liquefy the gelatine.

2. *Potato.*—On the cut surface of a sterilised potato the bacilli grow well, but on looking at the surface of such a potato nothing unusual is observed, at least on a cursory examination of the inoculated surface. On more careful examination, however, a thin almost transparent "skin" can be made out, and the smallest portion of this "skin" or pelicle on microscopic examination reveals the presence of a large number of little rods or bacilli with rounded ends. When the bacilli are examined under suitable conditions, they are found to be exceedingly motile, and not only are they motile, but they are exceedingly variable in length, and some are even so reduced in length as to resemble small spheres or micrococci.

Before considering the various modes of isolating the typhoid bacillus from contaminated water and milk, let me briefly call your attention to the various ways in which this contamination is brought about.

A. *The Contamination of Water.*—1. Through the medium of the air: (*a*) from "sewer gas" containing the germs of typhoid fever coming in contact with drinking water; (*b*) from noxious emanations from typhoid excreta in cesspools, on soiled linen, etc. It is important to note, in connection with emanations from typhoid excreta (as is the case with Asiatic cholera), that freshly passed excreta are not nearly so dangerous as excreta which have been exposed for some time to the air.

2. Through excreta getting directly into the drinking water. This has been a fruitful source of typhoid outbreaks. At the present moment an experiment on a large scale is being carried out across the border. I refer to the river Tees in England, into which the excreta from several of the villages along its banks find their way into its waters; also used for drinking purposes, with the consequence that typhoid fever is more or less prevalent along the valley of the Tees, breaking out every now and then—especially after heavy rainfalls—into severe and fatal epidemics.

3. Through an attendant on the sick. The question whether a person, himself unaffected, but who has been in attendance on a typhoid patient, may contaminate water,

etc., is still a disputed one, but obviously it depends very much on the precautions taken by the attendant himself, and accidental contamination of foods and drinks by such a person must not be lost sight of.

B. *Contamination of Milk.*—With reference to milk contamination, it is self-evident that the various ways in which water may be contaminated apply also to milk, and with even greater force, for milk is an excellent nutrient medium for germs of nearly all kinds, where they not only feed and live, but multiply abundantly. Milk may be contaminated in at least two other ways, viz.—(1) by the addition of typhoid contaminated water for purposes of adulteration; and (2) by the defective scouring of milk-vessels with infected water.[1]

Having thus briefly glanced over the various ways in which two of our commonest drinks may be so easily infected, I pass on now to consider the various methods which have been employed for detecting and isolating the specific germ of typhoid fever.

I have already drawn your attention to the fact that the discovery of Eberth's bacillus in water or milk establishes at once *the previous existence of a case of typhoid fever*, no matter what value we attach to the bacillus itself, whether it be the cause, concomitant, or effect of the disease.

To Robert Koch we owe the unique method of "plate" cultivation for the isolation of micro-organisms inextricably mixed up with each other. His method consists in inoculating tubes of melted nutrient gelatine with the suspected material, diffusing the latter uniformly throughout the tubes, and then pouring out the gelatine contained in them upon sterilised glass plates, with certain precautions against contamination by aerial organisms. The glass plates are placed in moist chambers in order to prevent the gelatine becoming too dry. The various organisms are thus spread out on flat surfaces, being held in position by the solidifying of the

[1] Another mode of contamination of the milk has been suggested, but has not found much support, viz., the direct secretion of the typhoid poison along with the milk; but it seems extremely improbable if any animal could have organisms multiplying within its body and yet remain unaffected.

gelatine on cooling; thus each organism is enabled to multiply *in situ*, and their general appearance, colour, various modes of growth can be watched from day to day either with or without the use of a lens. The number of spots of growth, or "colonies," as they are called, can be counted; and further, from these colonies various other nutrient media may be inoculated. In this way each particular set of organisms, or colony, can be studied apart from all the others.

Koch's plate-cultivation method, though very excellent for good drinking waters which have been accidentally contaminated, does not answer for impure or dirty waters, such, for example, as may be obtained from many surface wells. Such waters, as a rule, contain a number of liquefying organisms (*i.e.*, organisms which liquefy the gelatine as they grow), besides various moulds and other fungi, and these speedily grow up and choke the typhoid bacilli. Diluting the water abundantly before inoculating the gelatine plate does not always give positive results, for by diluting the water we scatter further apart the typhoid bacilli, and if they are not very abundant the chances that one will obtain a colony or growth of them in any particular plate are very much diminished. To obviate this overpowering of the typhoid bacilli by other non-important organisms, three distinct methods have been recently proposed. Briefly, they may be denominated—(1) the carbolic or phenic acid method; (2) the heat or high temperature method; (3) the differential staining method.

1. The first, or carbolic acid method, was proposed by Chantemesse and Widal in 1887.[1] To their gelatine for plate cultivation they added carbolic acid in the proportion of ·25 per cent. They maintained that this addition of carbolic acid prevented other micro-organisms from growing, though it had no such effect on the typhoid bacilli.

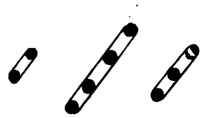
Chantemesse and Widal's method has been criticised pretty severely by Max Holtz[2] and others, and Holtz has shown that a percentage of ·25 of carbolic acid is far too high, such a strength of the acid effectually preventing the typhoid

[1] Gazette Hebdomadaire, 1887. [2] Zeit. f. Hygiene, Bd. viii., Heft 1.

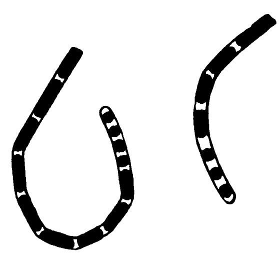
bacilli from developing. Holtz found that about half that percentage (0·117) of carbolic acid in gelatine allowed the bacilli to develop after a few days at the temperature of the room (16° to 20° C.). Holtz next made a cultivating medium of his own—consisting of a mixture of potato-juice and gelatine. He took 400 grams of the juice of *raw* peeled potatoes, and 40 grams of gelatine. The potato-juice he allowed to stand in a cool place (under 10° C.) for twenty-four hours before the gelatine was added to it. This nutrient medium has an acid reaction which is favourable to the growth of the typhoid bacilli; to this medium he added ·05 per cent. of carbolic acid, which hinders the growth of moulds for six to eight days, but does not interfere much with the development of typhoid germs, whose growth, according to Holtz, is only retarded for a day. Further, the typhoid bacilli develop in this medium in quite a characteristic manner—as transparent colonies—and are thus easily recognised. The potato-gelatine is sterilised in the usual manner, and streak cultivations in test-tubes may be employed. If, however, the suspected water or liquid be very impure, then to it must be added carbolic acid in such proportion as to make a ·25 per cent. solution of it. The water or liquid must in the next place be allowed to stand for three hours (at the temperature of the room), and then about 10 c.c. of the potato-gelatine must be seeded with ½ to 1 c.c. of this water or liquid, and cultivations made at the temperature of the room. It is to be noted that Holtz uses the same percentage (·25 per cent.) of carbolic acid mentioned by Chantemesse and Widal, but he allows the organisms to remain in such a fluid for only three hours before transferring to his potato-gelatine medium.

By the kind permission of Professor Chiene, I have been enabled to conduct a few experiments with the typhoid bacillus in his laboratory. I first made a weak solution of Liebig's extract, sterilised it, and added a 5 per cent. solution of carbolic acid to the extract, until I had a ·25 per cent. solution of carbolised extract. I then seeded it with some typhoid bacilli from a pure culture in gelatine, placed it in the incubator at 103° F., and examined drops of this extract

daily under the microscope. The result was that the bacilli underwent retrogressive changes very rapidly—in fact, after the third day I could obtain no traces of the original bacilli. It seems evident, therefore, that ·25 per cent. of carbolic acid is much too high, as the bacilli are speedily killed by it, at least in very weak solutions of Liebig's extract. The bacilli are not, however, so readily killed in milk diluted with its own volume of water, and to which carbolic acid is added till it amounts to ·25 per cent. of the whole mixture. The reason probably is, that some of the free carbolic acid combines with the proteids of the milk, and the antiseptic action of the acid is thereby considerably diminished.



CARBOLISED BROTH (3rd day). Protoplasm of Bacilli aggregated into sphere-like masses.



CARBOLISED MILK (3rd day). Bacilli elongated into filaments. Protoplasm broken up into spheres at one end of each filament.

2. The high temperature method of isolating the bacillus of typhoid fever was introduced by Rodet[1] about two years ago. He recommended a temperature of 44° to 44°·5 C., but he admitted that the *bacillus coli communis* (a fæcal organism) could withstand a higher temperature (46°·5) and yet grow well when inoculated into gelatine and "plated." In a somewhat later article Rodet and Roux[2] maintain that Eberth's, or the true typhoid, bacillus is nothing more nor less than the *bacillus coli communis* in a state of attenuation or degeneration.

Before passing on to the third method of isolating the typhoid bacillus from other micro-organisms, I should like to call your attention to Dr Vincent's method,[3] which appears to be a combination, with modification, of the first and second

[1] Comptes Rendus de la Soc. de Biologie, 1889, and No. 8, 1890.
[2] *Ibid.*, No. 7, 1890. [3] *Ibid.*, No. 5, 1890.

methods, viz., carbolic acid and heat combined. Dr Vincent's method is as follows:—One drop of a 5 per cent. solution of carbolic acid is added to each 2 c.c. of sterilised broth. He prefers to work with 8 c.c. of broth: this would therefore require 4 drops of the 5 per cent. solution of carbolic acid. He takes six such tubes of carbolised broth, and to each he adds from 5 to 15 drops of the suspected water. He then places the tubes in an incubator at a temperature of 42° C. If the typhoid bacilli be present, the broth turns cloudy in from eight to twelve hours. From these tubes inoculations are made into other tubes of carbolised broth, and the same process is repeated a third or fourth time; finally the bacilli are seeded into pure non-carbolised broth which has been thoroughly sterilised. According to Dr Vincent, the typhoid bacilli change their form in the carbolised broth (appearing as short twin bacilli and diplococci), but regain their usual rod form when transferred into non-carbolised broth. The motility of the bacilli is also considerably diminished in the carbolised medium.

3. The differential staining method was introduced by Noeggerath[1] about three years ago. It has more recently been employed by Grancher and Deschamps[2] for isolating the typhoid bacillus. The success of the method depends on the quality possessed by this particular bacillus to take up and retain certain of the analine dyes in preference to others. Holtz considers the test by itself of little value, but when combined with other methods of isolation, a most useful one for accurate diagnosis. Grancher and Deschamp's formula runs thus:—

Concentrated solution of	methyl blue,	2 c.c.
,, ,,	gentian violet,	4 c.c.
,, ,,	methyl green,	1 c.c.
,, ,,	chrysoidin,	4 c.c.
,, ,,	fuchsin,	5 c.c.

Mix and dilute with 200 c.c. of water.

Take from 7 to 10 drops of this stain to every 10 grams of nutrient gelatine; sterilise, seed with suspected material,

[1] Die Fortschritte der Medicin, Bd. vi., 1888.

[2] Archives de Medicine Experiment, et d'Anatomie Pathol., Heft 1, 1889.

and make "plate" cultivations in the usual manner; the typhoid colonies will alone be found to have taken up the violet stain.

Gasser,[1] however, employed a more simple method of isolating the typhoid bacillus. He coloured his gelatine with fuchsin, and found that both Eberth's (typhoid) bacillus and the *bacillus coli communis* discoloured the gelatine, but that the periphery of the growth of the former presented a sinuous or wavy outline, whilst that of the latter presented no such sinuous appearance.

IV. *On the Climate of Strathpeffer Spa.* By Fortescue Fox, M.D.

(Read 15th April 1891.)

The meteorological observations on which the present paper is founded were commenced in October 1884, and cover a period of about six years and a half, including seven winters. The instruments used are Negretti and Zambra's standard self-registering thermometers enclosed in a louvred screen, near the north side of my house; Simon's five inch rain-gauge well-exposed on the lawn; and, from December 1, 1889, one of Campbell's Sunshine Recorders. The latitude of Strathpeffer Spa is 57° 35′ 30″ N., and the elevation about 200 feet above sea-level.

The observer of natural configuration will often anticipate, in some points, the conclusions of the meteorologist. There are for each locality *prima facie* indications of its climate, more or less numerous and trustworthy. In the case of Strathpeffer, there is, first, *proximity to the sea*, which approaches by the Cromarty Firth to within five miles at Dingwall. This must imply that both high and low temperatures will be subject to a powerful moderating influence at all seasons, tending to reduce the range of the thermometer. Next, with regard to *situation* and *aspect.* Strathpeffer Spa lies in a rounded valley running nearly east and west. On the north is the bulky mass of Ben Wyvis, rising to nearly

[1] Compt. Rend., No. 27, 1890.

3500 feet. A narrow wooded ridge of 600 to 800 feet forms the southern boundary of the valley. The western end is closed by hills, which, at a few miles' distance, rise to 2000 and 3000 feet, and extend in a broken form across the country to the west coast. At the eastern extremity the Strath opens out, assumes its more typical form, and slopes down gradually to the sea. By this configuration northerly winds are excluded, and those from the west and south-west, often laden with rain, are obliged, before reaching Strathpeffer, to pass over a wide belt of hills. There follows hence not only a certain mildness in the winters, but also a comparatively low rainfall. It is also obvious that the sharp ridge of hill to the south must cut off from the southern slope of the valley a proportion of the winter sunshine, having regard to the low altitude of the sun in this latitude. Furthermore, the undulating and rounded contour of the surrounding hills is another indication of moderate rainfall, for in very wet districts the hills are usually cut into sharper forms. Lastly, numerous evidences of climate may be taken from the state of vegetation. In many other places an uniform deflection of the trees points to the prevalence of strong winds from one quarter. There is no appearance of that kind at Strathpeffer. It will be noticed that trees and shrubs of various species, including some of the more delicate coniferæ and rhododendrons, thrive exceptionally well. From this it may safely be inferred that they enjoy both shelter and warmth, and, more particularly, exemption from extreme degrees of winter cold. The hill slopes in the vicinity of the Spa are now, to a great extent, covered with plantations of larch and fir. This must influence the night temperatures, from the well-known circumstance that the currents of cold air which pass down at night from the hills into the valleys are intercepted and warmed by intervening woods.

It will thus be evident that commonplace observation may properly supplement the use of instruments in the determination of climate. The most varied phenomena may indeed be utilised for this purpose. In addition to what has been already mentioned, observations on the flowering and

fruiting of plants, on insect life, and on the appearance and migration of birds, would be of considerable value.

TEMPERATURE.

The adjoining table (I.) exhibits the principal temperature elements for the several months; and, for the sake of comparison, the corresponding particulars for the Royal Observatory, Greenwich. All the figures relate to the period November 1884 to February 1891 inclusive.

TABLE I.

	Mean of the Maxima.		Mean of the Minima.		Mean Temperature.	
	Strathpeffer.	Royal Observatory.	Strathpeffer.	Royal Observatory.	Strathpeffer.	Royal Observatory.
January,	40°·9	41°·6	32°·8	32°·4	36°·9	37°·0
February,	42·2	43·5	32·9	32·6	37·6	38·1
March,	43·4	47·7	33·6	33·2	38·5	40·4
April,	48·8	55·1	36·8	37·7	42·8	46·4
May,	55·6	64·1	42·6	44·2	49·1	54·2
June,	61·7	70·9	47·2	49·7	54·5	60·3
July,	62·4	73·6	49·5	52·6	56·0	63·1
August,	61·1	71·7	49·0	51·4	55·0	61·6
September,	57·9	66·4	46·0	48·5	52·0	57·4
October,	50·0	55·8	40·3	41·2	45·1	48·5
November,	44·9	48·7	36·4	38·2	40·7	43·4
December,	40·6	41·7	32·4	32·8	36·5	37·1

The annual *Mean Temperature* of Strathpeffer Spa is 45°·4, that is to say 3°·5 below that of London for the same period. Among the neighbouring meteorological stations, Culloden, about fifteen miles to the south-east of the Spa, has (for the forty years, 1841-80) a mean temperature of 46°·6; Dunrobin, to the north-east (1857-80), 46°·4; Wick, for the same period, 46°·0; and Aberdeen, 46°·5. It is quite probable that more extended observations will show a higher mean temperature for Strathpeffer, inasmuch as some recent years have been decidedly colder than the average. The warmest year of this short series was, 1889 (46°·5), and the coldest, 1886 (44°·3). The highest shade temperature of the six years was recorded on the 18th June 1887, when the

thermometer registered 79°·8, and the lowest was 12°, on 20th February 1885. The absolute highest and lowest readings in each year are given in Table II., in comparison with the Royal Observatory (London). It is a striking fact that in three out of six years the minimum readings were lower in the neighbourhood of London than at the Spa, the most remarkable case being 1890, the last year of the series. The mean of the lowest readings is precisely the same for the two stations. On the other hand, the mean of the highest (summer) readings is 75°·4 at Strathpeffer against 88°·2 at Greenwich. It follows that the *range* between the extreme temperatures of winter and summer averages about 13° less at Strathpeffer than at Greenwich, and this difference is almost wholly due to the more temperate climate of the summer.

TABLE II.—*Extreme Temperatures.*

	Maxima.		Minima.	
	Strathpeffer.	Royal Observatory.	Strathpeffer.	Royal Observatory.
1885, . . .	75·0°	90·2°	12·0°	22·3°
1886, . . .	76·3	89·8	16·2	16·5
1887, . . .	79·8	92·2	**19·0**	15·5
1888, . . .	73·8	87·7	17·0	18·4
1889, . . .	76·0	86·6	**19·5**	18·7
1890, . . .	71·8	82·8	**20·8**	13·1
AVERAGE, .	75·4	88·2	17·4	17·4

Table III. shows the *seasonal distribution* of temperature, which is a matter of especial importance at a health resort. It is observable that the *summer* is, on the average, six and a half degrees cooler at Strathpeffer than at Greenwich. The mean high day temperatures of the several summer months and the mean of the low night temperatures are given in the first table. Their difference represents the *mean daily range*, which is perhaps a more important element of climate

than the mean temperature itself. During June the mean daily range averages 14°·5 (at Greenwich, 21°·2); in July, 12°·9 (Greenwich, 21°·0); in August, 12°·1 (Greenwich, 20°·3). It follows that the average difference between night

TABLE III.—*Mean Temperature of the Seasons.*

	Strathpeffer.	Royal Observatory.	Difference.
Winter (December to February),	37°·0	37°·4	−0°·4
Spring (March to May),	42·6	47·0	−4·4
Summer (June to August),	55·1	61·6	−6·5
Autumn (September to November),	45·9	49·7	−3·8
YEAR,	45·4	48·9	−3·5

and day temperatures for the summer is 13°·2 at Strathpeffer against 20°·8 at London. The comparatively small daily range in the northern summer is, of course, owing to the relative coolness of the days, which, again, has been attributed to the influence of the sea, coupled with the free circulation of air on the hill-sides.[1] It is worthy of notice that, while the average day temperature falls about ten degrees below that of London, the corresponding difference between the night temperatures is only a little more than two degrees.

Winter Temperature.—We have just seen that the Strathpeffer summer is between six and seven degrees cooler than at Greenwich. The winter temperature presents a striking contrast, being, on the average of observations, within half a degree of that of London. The tendency, already noticed in the case of the summer months, to a comparative warmth of the night and a small daily range is still more marked in winter. This is shown in Table IV., which gives the average maximum, minimum, and mean temperatures for the seven winters from 1884-91. With regard to the minima, it appears

[1] See *Strathpeffer Spa, its Climate and Waters*, chap. ii. (by H. Courtenay late F.R.Met.Soc., to whom I am indebted for valuable aid in ing this paper).

to be a well-founded opinion that the average night temperature is of greater consequence in relation to health than the maximum or day temperature. It appears from this table that at Strathpeffer the minima are, on the average, slightly

TABLE IV.—*Winter Temperatures.*

	Mean of the Minima.		Mean of the Maxima.		Mean Temperature.	
	Strathpeffer.	Royal Observatory.	Strathpeffer.	Royal Observatory.	Strathpeffer.	Royal Observatory.
	°	°	°	°	°	°
1884-5, .	31·5	35·8	38·4	44·9	35·0	40·3
1885-6, .	**32·5**	31·6	39·1	40·6	35·8	36·1
1886-7, .	**32·1**	31·4	41·5	42·3	**36·8**	36·8
1887-8, .	32·1	32·6	39·7	41·0	35·9	36·8
1888-9, .	**34·0**	33·2	43·0	43·4	**38·5**	38·3
1889-90, .	33·9	34·5	43·5	44·4	38·7	39·4
1890-1, .	**32·9**	28·7	**42·9**	39·4	**37·9**	34·0
AVERAGE,	**32·7**	32·5	41·2	42·3	37·0	37·4

higher than at Greenwich—that is to say, the nights are, on the whole, a little warmer. Taking the entire winters, four times out of seven the night readings at Strathpeffer are slightly in excess of the corresponding readings in the neighbourhood of London. Taking the *highest or day readings*, there is a more decided difference between the two stations, amounting to 1°·1 in favour of London. This is, however, a very moderate deficiency in comparison with the ten degrees of difference in the day temperatures of summer. The *mean temperature* of the winter (by which in this paper the arithmetical mean is always to be understood) is 0°·4 lower at Strathpeffer; but in one of the seven winters it was exactly equal; and in two others (1888-89 and 1890-91) Strathpeffer was the warmer of the two. It is important to observe that these figures apply to a short series, which happens to include several seasons notable for generally diffused low temperature. Table V. shows the general distribution of winter temperature derived from readings extending over a much longer period,

all, with the exception of Culloden, being taken from the "Daily Weather Reports" of the Meteorological Office, and

TABLE V.

	°
Stornoway,	38·9
Wick,	37·8
Culloden (1841-80),	38·0
Nairn,	37·7
Aberdeen,	37·9
Leith,	39·5
York,	38 4
Cambridge,	38 7
Royal Observatory,	39·4

applying to the fifteen years 1871 to 1885. How unimportant appears to be the practical effect of difference of latitude, for one may expect to find a rather warmer winter in the Hebrides than at Cambridge or York! The north of Scotland is frequently unaffected by the long spells of severe Continental or European frost, of which the past winter has furnished a remarkable example. How much this fortunate exemption may be attributed to oceanic currents, and how much to the proximity of cyclones and the consequent prevalence of westerly or south-westerly winds, has yet to be determined.

RAINFALL.

No element of a climate is more dependent on the natural configuration of a locality than rainfall. A writer in 1772[1] correctly attributes the low rainfall of the immediate vicinity of the Spa to the screen of hilly country lying to the west. "It is worth while remarking," he says, "that the western mountains make the weather alternately foul and fair on the east and west borders of them, in some measure similar to the monsoons on the Malabar and Coromandel coasts. The west and south-west winds blow most frequently, during which it generally rains on the west coast and is fair weather on this side of the hills, or at most there are only slight occasional showers. On the other hand, the east wind

[1] Statistical Account of Scotland, vol. vii., p. 247.

uniformly [?] brings rain or sleet on the east coast, but the storm dies away in the intermediate hills, and there is dry weather and sunshine on the west coast."

There is unfortunately no systematic record of the comparative frequency of easterly and westerly winds at Strathpeffer. A gentle easterly current is not infrequent, particularly in the early morning. Occasionally it may be noticed, passing up the centre of the Strath, between two returning "valley winds" or local currents. During spells of prevalent easterly current, Strathpeffer is sometimes enveloped in a thin white sea mist, which is the only approach to fog met with in this district.

On the average of the six years 1884-90, the rainfall of Strathpeffer is 29·42 inches. This falls within Mr G. J. Symon's second lowest grade, from 30 to 25 inches, the first

TABLE VI.

	Mean Rainfall. Inches.		Number of Rainy Days.
	Strathpeffer.	Royal Observatory.	Strathpeffer.
January,	3·00	1·68	17
February,	2·25	1·25	17
March,	2·35	1·68	15
April,	1·87	1·70	14
May,	1·81	2·22	16
June,	1·61	1·88	13
July,	2·46	2·94	17
August,	2·40	2·13	18
September,	2·20	1·72	16
October,	3·27	2·04	17
November,	3·35	2·42	17
December,	2·86	1·70	18
YEAR,	29·43	23·36	195

or lowest being below 25. The area of lowest rainfall includes a considerable portion of the eastern half of England, and some districts on the Scottish coast north and south of the Moray Firth. Strathpeffer Spa is at the border of one of these limited very dry areas, at the junction of low and higher

rainfalls. At a few miles distance among the hills to the west of the Spa, the precipitation is nearly doubled, and across the country at Strome it is more than doubled. Tables VI. and VII. give first the monthly distribution of rainfall and the number of rainy days, and secondly a comparative view of the rainfall at several Scottish stations, with the years on

TABLE VII.

Station.	Date.	Inches.
Sandwick, ...	1860-83	37·23
Strome Ferry, ...	1872-83	65·30
Dunrobin, ...	1860-83	30·08
Invergordon, ...	1865-83	27·26
Dingwall, ...	1865-81	27·50
Strathpeffer, ...	1885-90	29·43
Culloden, ...	1860-83	26·17
Nairn, ...	1863-83	23·92
Edinburgh, ...	1860-83	28·31
Glasgow, ...	1860-83	43·00

which the averages have been calculated. At Strathpeffer the driest year of the series was 1887 (26·36 inches); the wettest 1890 (33·76 inches). The last-named year also furnishes the wettest month of the entire period—viz., October—with a fall of 6·11 inches. There have been in the six years besides this instance three months when the rainfall touched 5 inches, once each in January, July, and November. On nine occasions it has fallen below 1 inch. It is observable that nearly one-half of the annual rain occurs in the four months October to January. February has a low rainfall; April, May, and June form together the driest period of the year, June having the lowest monthly average. From May to July the record is slightly below that of London for the corresponding period. November is so far the wettest month of the year.

SOLAR RADIATION.

It remains to give some account of the solar radiation at Strathpeffer Spa, in so far as the present limited observations permit. A brief consideration of the influence of latitude

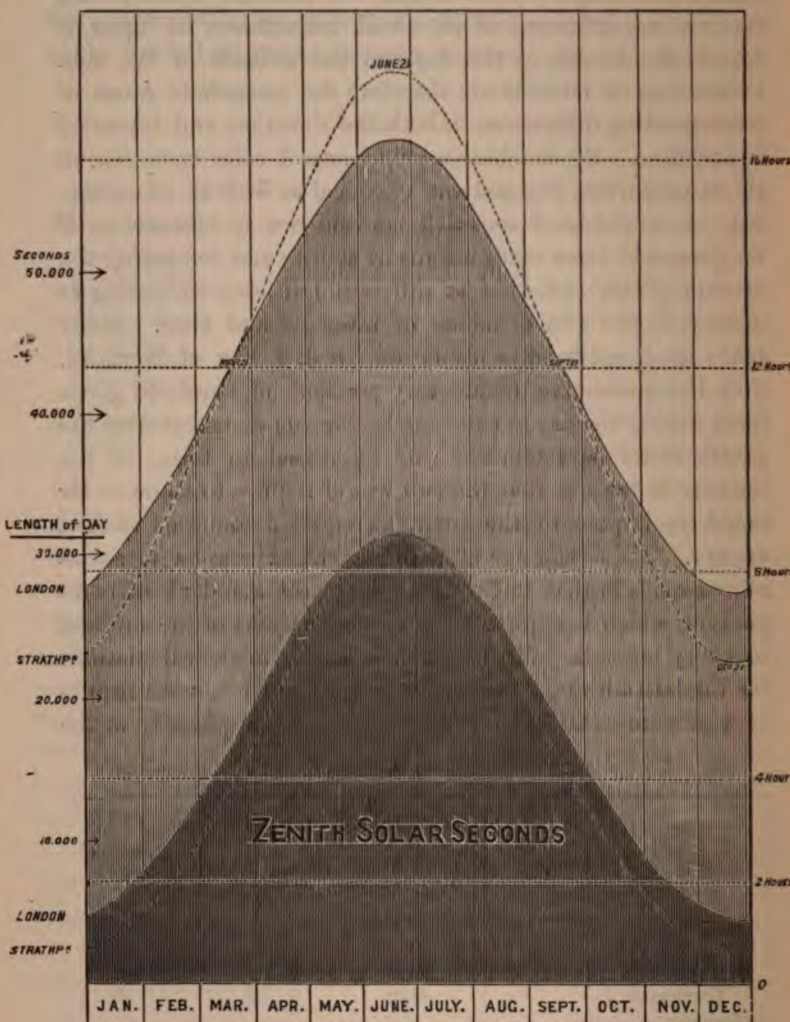
may suitably introduce this last portion of the present essay.

The latitude of a given place, though only one of many factors that combine to form what we term its *climate*, must exercise an influence of no small importance, for upon it depend the length of the day and the altitude of the sun. Differences of latitude are therefore the immediate cause of corresponding differences in both the duration and intensity of sunshine. By sunshine we understand solar radiation, in all its properties, thermal and chemical as well as illuminating. It would be of no small convenience in climatology if we possessed some ready means of stating and comparing the amount of this radiation at different latitudes, embracing as it must do the two elements of intensity and time. Many years ago it occurred to my father, Dr J. J. Fox of Hertford, that the successive momentary portions of sunshine given forth during the day at continually-varying distances from the zenith could be integrated and expressed in terms of the number of seconds that the sun would require to shine *in the zenith* to impart to the earth an equal amount of radiant energy. The advantage of reducing the expression to *zenith solar seconds* is that it furnishes a perfect standard of comparison, which is applicable to all declinations of the sun and to every latitude. My father has kindly made calculations for the latitudes of Strathpeffer and Greenwich, some results of which are exhibited in Table VIII., and graphically in the

TABLE VIII.

	Zenith Solar Seconds.		Length of Day.
	In Seconds.	Hours and Minutes.	
		H. M.	H. M.
Winter Solstice—			
Strathpeffer, . .	2340	0 39	6 17
Greenwich, . . .	4620	1 17	7 36
Equinox—			
Strathpeffer, . .	14760	4 6	12 0
Greenwich, . . .	17100	4 45	12 0
Summer Solstice—			
Strathpeffer, . .	31320	8 42	17 43
Greenwich, . . .	31560	8 46	16 24

diagram. In the table four equidistant periods, for brevity's sake, have been taken—the two equinoxes and the winter and summer solstices. At the winter solstice, while the sun is



above the horizon at Greenwich for 7 hrs. 36 mins., 'the aggregate radiation, supposing it to shine throughout the day *without diminution from atmospheric causes,* is exactly equal

to that which would be given forth if it were stationary in the zenith for 1 hr. 17 mins. Again, at Strathpeffer Spa, the shortest day has a length of 6 hrs. 17 mins., and the zenith solar seconds, representing the aggregate power of the sun for that day, amount to just 39 mins. At the equinoxes, whilst of course the length of the day is the same at the two stations, the zenith value of the solar radiation is 4 hrs. 45 mins. at Greenwich against 4 hrs. 6 mins. at Strathpeffer. This reduction at the more northern station is due simply to the lower altitude of the sun, and the consequently greater obliquity of its rays. Lastly, at the summer solstice the length of the day at Strathpeffer has expanded to 17 hrs. 43 mins., being 1 hr. 19 mins. longer than at Greenwich; whilst the zenith solar seconds are nearly equal, amounting to 8 hrs. 42 mins., against 8 hrs. 46 mins. at Greenwich. It follows that in summer the greater length of the day in the north of Scotland nearly compensates the loss of radiation involved in the lower altitude of the sun; whilst in mid-winter, on the contrary, the lower altitude and shorter day combine to reduce the radiation to nearly one-half the amount at London. The diagram is intended to exhibit the same facts by aid of curves. The full-curved lines represent respectively the length of day and the zenith solar seconds (zenith values) for London, and the dotted curves those for Strathpeffer.

If the surface of the earth were smooth and homogeneous, and there were neither sea nor air upon it, it would be a comparatively simple matter to assign the climate of each parallel of latitude by ascertaining the zenith solar seconds proper to that parallel. We have, however, already seen how powerfully both temperature and rainfall are affected by causes independent of latitude, by proximity of sea or of mountains, by oceanic currents and currents in the atmosphere, or winds. These influences may be so strong as to compensate the effects of diminished solar radiation, and give to a northerly station, such as Stornoway, the same degree of warmth as is enjoyed by places many hundreds of miles farther south.

There is, however, another powerful factor of climate which

directly governs the available solar radiation, and affects its amount no less surely than the degree of latitude. This is the *state of the atmosphere,* in respect to its transparency for the solar rays. The term transparency, as here and subsequently used, must be taken as including not only transparency to light, but to radiant heat (diathermancy), and to all other forms of radiant energy. The radiation values obtained above by calculation from latitude are, in point of fact, ideal values, for they take no account of the exceedingly powerful and variable factor—atmospheric absorption. The atmosphere determines for each place and season and day what proportion of the ideal radiation shall actually reach and affect the earth. Are there, then, any means of accurately representing this important element of climate? If some adequate expression could be devised for the state of the atmosphere in respect to its transparency for the solar ray, at different places and different times, it is obvious that it would only be necessary to combine this expression with zenith solar seconds in order to obtain the true value of the actual radiation received. Meteorological science has made an important advance in this direction. Of late years a mass of information has been accumulated at different stations, by instruments designed to record the duration of *bright sunshine.* In point of fact, Campbell's, which, with slight modifications, is the form most commonly employed, being essentially a large burning-glass, records the solar *heat;* and Jordan's photographic recorder is affected by the *chemical* energy of the solar ray. Assuming, however, that these instruments may be fairly comparable, we have now a most interesting view of the *duration* of radiation of a certain intensity at the different localities.

Table IX. shows the sunshine records for Strathpeffer for each month from December 1889, compared with the corresponding records for Braemar, Royal Observatory, Meteorological Office Westminster, and, as a typical English winter health resort, Falmouth. The two last columns exhibit the percentage of possible duration for Strathpeffer and London respectively. It will be observed that the brightest month of this short series is May (184 hours), and the dullest

January (28 hours). The total for 1890 is 1223 hours against 1043 in London. The percentage of possible duration is calculated from the approximate average length of the day for each month at the two stations. The highest percentages are found in the months April, May, and September; and it must follow that in these months there was a high degree of atmospheric transparency. It is worth observing that in these months the rainfall was decidedly below the average, as well as the number of so-called "rainy days."

TABLE IX.

	Duration of Bright Sunshine in Hours.					Percentage of Possible Duration.	
	Strathpeffer.	Braemar.	Royal Observatory.	Westminster.	Falmouth.	Strathpeffer.	Westminster.
1889. December,	30	21	20	7	61	15·4	2·9
1890.							
January, .	28	24	44	39	45	12·5	15·0
February, .	80	72	63	26	105	29·6	9·4
March, .	99	97	91	63	142	27·6	17·2
April, . .	157	139	141	100	170	37·6	24·1
May, . .	184	158	224	180	190	36·8	37·5
June, . .	142	137	125	107	169	26·5	21·6
July, . .	108	126	121	117	135	20·6	23·6
August, .	133	114	153	158	210	28·5	35·0
September,	126	128	153	125	156	34·0	33·0
October, .	84	81	97	94	137	27·5	28·5
November,	51	45	41	33	88	22·0	12·7
December,	31	9	2	0	19	15·4	0·0
1890	1223	1130	1255	1042	1566	26·6	21·5

It should be stated that the radiation records at Strathpeffer are necessarily checked by the hilly contour of the valley. There is a wall of 500 to 700 feet on the south and west, which brings about a premature sunset in winter; whilst on the north-west of the Spa hills of from 1000 to 1500 feet cut off from the northern side of the valley, where the instruments are mounted, all sunshine after about 6.30 P.M.; although very frequently the south side of the valley remains in brilliant sunshine as late as eight o'clock on a summer's evening. Finally, it must be borne in mind that *aspect*, on a slope facing south or south-west, will compensate, in some degree, for the obliquity of the sun's rays.

The seasonal distribution of sunshine at Strathpeffer, in so far as it may be judged by the observations of a single year, is given in Table X., in comparison with Westminster. Spring is marked by a high percentage of sunshine, that is

TABLE X.

1890.	Hours of Sunshine.		Percentage of Possible Duration.	
	Strath-peffer.	West-minster.	Strath-peffer.	West-minster.
Winter (Dec., Jan., Feb.),	139	65	19·2	8·0
Spring (March to May), .	440	343	34·0	26·3
Summer (June to August),	383	382	25·1	26·7
Autumn (Sept. to Nov.), .	261	252	27·8	24·8

by an exceptionally clear atmosphere, whilst in summer the percentage was considerably less, and indeed fell slightly below the Westminster standard. It is particularly noticeable that the winter months show a total of 139 hours against 65 in London.

The winter sunshine of these islands, and particularly of a station to which invalids are accustomed to resort, is a matter of especial interest, and the question suggests itself whether it is possible to form an approximate statement of the actual value of the winter radiation, say at Strathpeffer Spa and at London. In the first place the records show that in spite of a mean loss of an hour in length of the winter day, the *duration* of measurable radiation is in proportion of more than two to one in favour of the northern station. Secondly, this duration, as recorded, represents nearly one fifth of possible duration at Strathpeffer, and a little more than one-twelfth at London (19·2 per cent. and 8·0 per cent. respectively). Now it appears from the calculation of zenith equivalents that for the average winter day in London the mean zenith value of radiation is 2·66 hours, and at Strathpeffer 1·32 hour approximately. The fraction one-twelfth, expressing duration, obviously cannot be taken as an expression of intensity or value. For what affects the instrument on a winter's day is, as a rule, the comparatively intense

sunshine of the middle part of the day, and this must be much more than a sample or average of the entire day's radiation. But since these facts apply equally or nearly equally to all stations, it may be permissible to use the fraction for duration in an expression for comparative intensity or value. Thus the fraction one-twelfth multiplied into 2·66, the mean daily value in zenith radiation, gives an expression 0·22, which although not the actual zenith value of the London winter's day, is legitimately comparable with corresponding expressions similarly derived from the data proper to other localities. The corresponding expression for Strathpeffer Spa is 0·26 (one-fifth of 1·32); and we thus arrive at the result that the actual zenith value of radiation recorded at Strathpeffer during the winter is to that of London as 26 to 22. That is to say, the *amount* or *value* of solar energy in the form of light, heat, and chemical force actually transmitted by the atmosphere and received by the earth is just one-seventh more at the northern station.

The importance of the atmosphere as a factor determining the amount of the solar radiation has been already insisted upon. There are, however, as yet no means of observing or recording the condition of this element at different times and places. There is no standard of atmospheric purity or transparency, using that term in the wide sense above defined. Valuable data may be forthcoming from an examination of the sun's rays, as they reach us under varying conditions of the air. The different elements of the solar radiation—luminous, thermal, actinic—are intercepted and absorbed more or less in all states of the atmosphere. It is required to assign this obstruction or absorption to the proper element or elements of the atmosphere by which it is occasioned, whether aqueous vapour (humidity), or solid or liquid matters in suspension. If it were possible so to measure and interpret the loss of the sun's beams, we should at once have the desired criterion of the atmospheric state. But at present we have only general facts and inferences. It is obvious that in place of giving free passage, the atmosphere exacts a more or less heavy tribute, differing widely in amount in different places. And it is allowable to infer that the simple duration

of bright sunshine, or better, the percentage of possible duration, is a fair measure of the atmospheric transparency. When this percentage rises, as in the spring of 1890, to as much as 33 (one-third of possible duration), the transparency of the air may be regarded as unusually high.

In comparing the records of different localities with a view to estimating the atmospheric state of each, a correction must be introduced for differences in the depth of atmosphere traversed. At Strathpeffer, for example, the solar rays, coming obliquely from their source at a comparatively low altitude, traverse a wider belt of atmosphere than is the case farther south. It follows that *the same percentage of sunshine implies a greater transparency of the atmosphere the farther north it is recorded;* that is, the longer and more oblique its course through the aërial envelope of our planet. Now at Strathpeffer and London the winter percentages of possible duration of sunshine are respectively 19·2 and 8, or very nearly as 2½ to 1. When to this difference is added the further difference arising from the greater depth of the atmosphere traversed at the more northerly station, it is safe to conclude that the transparency of the air is at least three times greater at the Spa than in the neighbourhood of London.

V. *On the Fructification of* Sphenophyllum trichomatosum, *Stur, from the Yorkshire Coal Field.* By ROBERT KIDSTON, F.R.S.E., F.G.S. [Plate I.]

(Read 15th April 1891.)

The earliest figure of *Sphenophyllum* is probably that given in 1804 by Schlotheim in his "Beschreibung merkwürdiger Kraüter-Abdrücke und Pflanzen Versteinerungen," pl. ii., fig 24, and described on p. 57. Schlotheim here supposes his fossil to belong to the palms. In his "Petrefactenkunde" (1820-23) he named his specimens *Palmacites verticillatus.*

In 1822 Brongniart created the genus *Sphenophyllites* for these fossils,[1] and in his "Prodrome"[2] he names *Palamacites*

[1] Sur la Classification et la Distribution des végétaux fossiles en général, etc., in Mem. du Muséum d'hist. nat., vol. viii., p. 34, pl. ii., fig. 8, *Sphenophyllum emarginatum.*

[2] 1828, p. 68.

verticillatus, Schl., *Sphenophyllum Schlotheimii*,[1 2] he having modified the orthography of *Sphenophyllites* to *Sphenophyllum* in this work.

The cones of certain species of *Sphenophyllum* were early known in the form of impressions, but it is only in recent years that their structure and the arrangement of the sporangia have been understood.

In 1838 Presl described a specimen showing two laterally developed cones, which he identified as *Rotularia marsileæfolia*, Sternb.[3]

In 1845 Germar figured several species of *Sphenophyllum* in fruit.[4]

Geinitz figured a cone of *Sphenophyllum emarginatum* in 1855, which showed the sporangia, but not so preserved as to show their attachment to the bracts.[5]

Some fruiting specimens of *Sphenophyllum* are also given by Lesquereux[6] and Weiss.[7]

None of these specimens, however, afford any clear information as to the arrangement and attachment of the sporangia within the cone.

Renault was the first to describe the minute structure of the cones of *Sphenophyllum*, from which botanists were enabled to form an idea of the systematic position of the genus.[8] Grand' Eury also gives details of their fructification.[9]

[1] In justice to Schlotheim, whose figure is very characteristic, the original specific name of *verticillatum* must be restored to his species. Irrespective of the rules of priority, this is especially desirable, as Brongniart's *Schlotheimii* has been very loosely applied, and seldom to the correct plant. The *Sphenophyllum Schlotheimii*, L. and H. (Fossil Flora, vol. i., pl. xxvii.), is the *Sphenophyllum emarginatum*, Brongt. *Sphenophyllum verticillatum*, Schl. sp., is apparently a rare plant, which has not yet been discovered in Britain.

[2] The genus *Rotularia* was formed for the same plants by Sternberg in 1823 —Essai Fl. du monde prim , vol. i., fasc. 2, pp. 34, 37.

[3] Beiträge zur Kunde Vorweltlichen Pflanzen—Verhandl. d. Gesell. d. Vater. Museums in Böhmen, Prag., 1838, p. 29, pl. ii., fig. 2.

[4] Vers. d. Steink. von Wettin u. Löbejun., fasc. ii., *Sphenophyllites Schlotheimii*, pl. vi.; *Sphenophyllites angustifolius*, pl. vii., figs. 5, 6.

[5] Vers. d. Steinkf. in Sachsen., p. 12, pl. xx., figs. 7, 7*a*.

[6] Coal Flora—Atlas, 1879, vol. i., 1880, vol. iii., 1884.

[7] Foss. Flora d. jüngst. Stk. u. Rothl., p. 136, pl. xviii., fig. 33. *S. angustifolium*.

[8] Ann. d. Sc. Nat. Bot., 6e sér., vol. iv., 1876, pp. 277-311, pls. vii.-ix.

[9] Flore carbon. du Départ. de la Loire et du centre de la France, 1877.

The structure and classification of *Sphenophyllum* is also fully entered into by Renault in his "Cours d. botan. foss,"[1] by Schimper,[2] and Schenk,[3] who gives some good figures of cones of *Sphenophyllum*, especially that on his pl. xxxviii., fig. 2 (*Sphenophyllum angustifolium*). Some excellent illustrations of the fructification of this genus are also given by Zeiller in his "Flore foss. d. bassin houil. d. Valenciennes."[4]

It is not my intention to review the various opinions held by different writers on the systematic position of *Sphenophyllum*, as that has been done by several of the botanists who have lately written on the subject, and their works are very accessible. After describing the Yorkshire specimens which form the subject of this communication, I will, however, make a few remarks on the systematic position of the genus.

SPHENOPHYLLUM, Brongt.

Stems and branches with prominent, slightly swollen nodes, ribbed longitudinally, ribs not alternating at the nodes. Leaves in verticils, variable in number, seldom less than six in a whorl, cuneiform, entire or dentate, or more or less deeply divided into segments; or the leaves are composed of narrow linear, dichotomously divided segments, veins dichotomous, spreading from the base of the leaf—one veinlet extending into each tooth or ultimate segment of the leaf. Fruit strobiliform, heterosporous, terminal or lateral, cylindrical, internodes short, bracts verticillate, more or less kneed, the sporangia being placed on the bracts close to the knee, or in the axil of the knee which is formed by the sudden uprising of the blade of the bract. Axis solid, primary vascular axis three-rayed or triangular, subsequently becoming more or less circular through increase to its periphery, and surrounded by a thick bark.

[1] Deuxième Année, p. 81 *et seq.*, 1882.

[2] Traité d. paléont. végét., vol. i., 1869.

[3] In Richthofen's China, vol. iv., Palæontologischer Theil. Berlin, 1883.

[4] Pp. 409, 413, pl. lxiii., figs. 4, 4*a*, 5, 5*a*, 10, 10*c*, *Sphenophyllum cuneifolium*, var. *saxifragæfolium*; pl. lxiv., figs. 5, 5*a*, *Sphenophyllum emarginatum*, Atlas, 1886; Text 1888.

The structure of the stem has been fully described by Renault[1] and from a specimen of a cone preserved in silica, which was discovered at St Etienne, he was enabled to determine the heterosporous condition of the sporangia.[2]

SPHENOPHYLLUM TRICHOMATOSUM, Stur.

Asterophyllites trichomatosus, Stur, *et Sphenophyllum trichomatosum*, Stur, Die Carbon Flora der Schatzlarer Schichten, Abth. ii. Die Calamarien der Carbon-Flora der Schatzlarer Schichten, p. 202, pl. xv., figs. 1-4, 1887 (in Abhandl. d. k. k. geol. Reichsanst., xi. Band., ii. Abth., Wien, 1887).

Sphenophyllum tenerrimum, Weiss (*not* Ett.), Aus d. Steink., 1882, p. 12, pl. x., fig. 63.

„ „ Weiss, Steinkohlen-Calamarien, vol. ii., p. 199, pl. xvi., figs. 4, 5, 1884 (Abhandl. z. geol. specialkarte von Preussen u. d. Thüringischen Staaten, Band v., Heft 2, 1884).

Description.—Stem jointed, slightly swollen at the nodes, furrowed, surface of stem bearing numerous, irregularly-placed fine apiculi, ramification lateral, irregularly developed leaves verticillate, about eight in a whorl, formed of narrow linear single-veined segments with truncate extremities, dichotomising, about as long or longer than the internodes; cones with short internodes and many verticils of bracts; sporangia ovoid, placed on the horizontal portion of the bract a short distance from the axis.

Remarks.—I am indebted to Mr W. Hemingway for several specimens of the fruit of *Sphenophyllum trichomatosum*, Stur. They are preserved in a light grey fine-grained shale, and though none of the cones shows its complete length, they exhibit very clearly the arrangement of the sporangia.

Figs. 1 and 2 (*d*) give their general structure. The internodes are short, and the bracts do not appear to be so much or so suddenly bent upwards in their distal portion as in some other species of *Spenophyllum*. The position of the

[1] Ann. d. Sci. Nat., vol. iv., Bot., 1876, pp. 277-311. See also Renault, Cours d. botan. foss., vol. ii., 1882; Felix, Untersuch. über d. inneren Bau westfälischen Carbon-Pflanzen—Abhandl. k. Preussischen geol. Landesanstalt, vol. vii., Heft 3. Berlin, 1886.

[2] Ann. d. Sci. Nat., vol. iv., Bot., p. 303, pl. ix., fig. 9.

sporangia is well seen in fig. 1, at the part marked *a*. The oval sporangia (which have thick walls, as indicated by the amount of carbon they possess) stand upright on the bracts a short distance from their point of attachment to the cone. The bracts marked *a* in fig. 1 are shown enlarged at fig. 1*a*.

A small portion of a stem—that exhibited at *b* in fig. 2, and marked with a *, is enlarged at 2*a* to show the small thorn-like points which are irregularly scattered over its surface.

Perfect specimens of verticils of leaves are very rare. Figs. 3 and 4 show, however, their general structure and appearance. In the upper example in fig. 4 the leaves are simply dichotomous, or sometimes one of the forks divides again. In fig. 3 the leaves are either dichotomous, or one fork divides again, or both of the arms of the primary fork dichotomise.

In describing this species, Dr Stur mentions *Asterophyllites trichomatosus* and *Sphenophyllum trichomatosum*, "Rami speciei calamitarum mihi ignotæ," and refers to his specimens as showing the union of *Asterophyllites* and *Sphenophyllum* in one and the same plant, from which, according to his view, it follows that Calamites had two forms of branches —one the generally recognised foliage of *Calamites*—the *Asterophyllites*, and the other the genus *Sphenophyllum;* and not only are these two genera the foliage of *Calamites*, but are both found on the same species of *Calamite*.[1] That this conclusion is thoroughly erroneous can be seen by any one who cares to study the subject, and it has originated entirely from the misinterpretation of his specimens.

When slabs containing *Sphenophyllum* are split, a few of the verticils of leaves or the leaves themselves are frequently broken through in section, while on other verticils the leaves may be spread out, or the specimen might be in part badly preserved. At *b*, fig. 2, is given an example which explains these remarks. On the remains of the uppermost verticil of leaves is shown a fragment of a leaf which exhibits the characteristic dichotomy of the foliage of *Sphenophyllum trichomatosum*. In the second verticil the leaf is either cleft

[1] See Dr Stur's Restoration, p. 69.

or the other fork buried in the matrix, and here is the *Asterophyllites trichomatosus*, Stur; but this latter "species" merely results from imperfect preservation, through the leaf being cleft or only partially exhibited, and on similar specimens to this has been founded the theory, that a single species of *Calamite* might bear both *Asterophyllites* (*Calamocladus*) and *Sphenophyllum* as its foliage. The differences of internal structure of the stems and of the arrangement of the sporangia in the cones, in *Calamites* and *Sphenophyllum*, is entirely ignored, and their union proposed upon evidence which will not stand being looked into.

In regard to the systematic position of *Sphenophyllum*, there is, I believe, no recent order in which it can be enrolled. It differs from the *Equisetaceæ* in its solid axis and the structure of the cone; from the *Lycopods* in its noded and ribbed stems with verticillate leaves; and with the *Rhizocarps* it appears to have little or nothing in common.

The *Sphenophylli* form a peculiar group of plants, which, though standing close to the *Lycopods*, cannot be included with them, but must be placed in a class by themselves—the *Sphenophylleæ*. This view is that which is generally adopted.

Before closing these notes, I would wish to refer to an opinion, which has often been vaguely expressed, that the *Sphenophylleæ* were aquatic. This view appears to rest on the dimorphic condition of the leaves of certain species of *Sphenophyllum*. To mention a common example, the leaves in typical *Sphenophyllum cuneifolium* are cuneate-dentate, but in other cases they are more or less divided into narrow dichotomous segments, and then form the var. *saxifragæfolium*. The occurrence of these two forms of leaves in the same species has led to the idea that *Sphenophyllum* grew in such situations that at times it was wholly or in part submerged. I do not think, from the dimorphic character of the leaves alone, we are warranted in accepting such a conclusion, especially as we find the *saxifragæfolium* form of leaf associated with the fructification of *Sphenophyllum cuneifolium*, and I do not think there can be any doubt as to its fructification having been aerial. If, however, one is inclined to adopt the aquatic nature of *Sphenophyllum*, founding his opinion on the

dimorphic condition of the leaf, how can such specimens as that figured by Germar under the name of *Sphenophyllites Schlotheimii* be explained, where entire and much divided leaves occur mixed together in the same individual specimen.[1]

Explanation of Plate.

Sphenophyllum trichomatosum, Stur.

Figs. 1, 2. From Cooper's Pit, Worsbro' Dale, near Barnsley, Yorkshire; natural size. *Horizon.*—From "Rock" over Barnsley Thick Coal. Middle Coal-Measures.

1*a*. Portion of specimen seen on fig. 1, marked *a*, enlarged, showing position of sporangia on bracts.

2*a*. Portion of *b* marked with a * on fig. 2, enlarged two times to show small spiney points on outer surface.

Figs. 3, 4. Portions of leaf whorls; natural size. *Horizon.*—Shale over Barnsley Thick Coal, Barnsley. Middle Coal-Measures.

VI. *On the Pineal Eye of* Lamna cornubica, *or Porbeagle Shark.* By G. Carrington Purvis, M.D., B.Sc. Edin. [Plate II.]

(Read 18th March 1891.)

In the early part of 1890, I received from Professor Ewart a small portion of the head-region of an embryo *Lamna cornubica.* The portion included the pineal body, its stalk, and the overlying skin. The specimen was not in a very good state of preservation for detailed histological investigation, yet as embryo Porbeagle sharks are rarely obtainable, I was glad to get an opportunity to investigate this portion of the head-region as fully as the single specimen would enable me to do so. This I did by making a series of longitudinal vertical sections through the skin and underlying tissues of the region made over to me for examination.

The pineal "gland," as it used to be called, was a problematical body to morphologists and embryologists till 1882. In that year Rabl Rückhard[2] first pointed out that the pineal body or "gland" developed in a manner exactly

[1] Vers. d. Steinkf. v. Wettin u. Löbejun, pl. vi., fig. 3.

[2] Archiv f. Anat. und Physiol. (part Anatomie), 1882.

similar to the primary optic vesicles of the lateral eyes. Two years later, Ahlborn [1] also drew attention to this resemblance. But it was in 1886 that Graaf [2] maintained that the pineal eye of *Anguis fragilis* resembles the highly-developed invertebrate eye, such as that of a Cephalopod, Heteropod, or Pteropod. This view of Graaf has been adopted more recently by Mr Spencer [3] and Dr Beard.[4]

Appearances presented by a longitudinal vertical section, made through the centre of the pineal body, its stalk, and the overlying skin.

Almost directly over the expanded end of the pineal body (Plate II., Fig. 1), but separated from it by mesoblastic tissue, there is (1) a well-marked involution or depression (*P.P.*) of the epidermis or epiblast (*Ep.*), which at this spot is not only thickened, but is made up of at least two distinct layers of cells (Fig. 2, *Ep.*), whereas the epidermis in the immediate neighbourhood of the depression is composed of only a single layer of cells. Below the epidermis lies (2) the thick stratum of clear embryonic mesoblastic connective tissue (*E.c.t.*), in which are scattered a number of connective tissue-corpuscles, and in which the formation of cartilage (*c.*) has just begun at certain spots, but not immediately over the pineal body. In a shallow concavity or depression on the under surface of this tissue, and almost immediately under the epiblastic involution, lies the expanded distal extremity of the pineal body (*P.B*). From the ventral extremity of the latter stretches a long, slightly curved, and posteriorly-directed stalk (*P.St.*), which, like the body, is a hollow structure, and places the cavity of the body in direct continuity with the ventricles of the brain. The greater portion of the stalk, together with pineal body or "vesicle," is, however, embedded in (3) a somewhat thick stratum of very delicate protoplasm (*c.c.t.*), so transparent as to be recognised with difficulty under the microscope. In it lie scattered a few nucleated corpuscles. The parts of interest are, however, the epiblastic

[1] Zeitschr. f. Wiss. Zoologie, 1884. [2] Zool. Anzeiger, March 29, 1886.
[3] Quart. Journ. Micros. Sci., 1886 (vol. xxvii.).
[4] Quart. Journ. Micros. Sci., 1888-89 (vol. xxix.); Nature, July 14, 1887.

involution or pit, the dilated portion of the pineal body or primary optic vesicle, and the hollow stalk of the latter.

1. *The Epiblastic Involution or Pit*—on surface view before the sections were made—appeared as a distinct though small circular depression quite visible to the naked eye, in the mid-dorsal surface of the head of the embryo shark. On examining a longitudinal vertical section of the pit, a secondary depression (*s.p.*, Fig. 1), even with comparatively low powers of the microscope, was distinctly observable. As this secondary depression was noticed in a large number of sections, it was probably natural, and not due to shrinkage or any other untoward accident. The epiblast was thickened throughout the whole extent of both the primary and secondary depressions, and consisted of at least two layers of cells. Most of the cells resembled those of the epiblast in the rest of the head-region, *i.e.*, they were circular or ovoid in section, each with a comparatively large nucleus, whilst here and there occurred a few large cells (*m.c.*, Fig. 2), usually in groups, with clear contents and small nuclei (probably mucous cells). A few such cells, however, occurred in the adjoining epiblast, but they were not, as a rule, in groups.

2. *The Primary Optic Vesicle or Pineal Body.*—In sections passing through the centre of the vesicle, its outer surface is seen to be distinctly conical, its upper or dorsal surface convex, and occupying a depression in the embryonic connective tissue—almost immediately under the epiblastic involution. The central cavity of the pineal body, though conforming in a general way to the outer conical surface of the vesicle, is sufficiently irregular to call for remark. On looking at the figure, it is at once seen that the anterior wall of the vesicle (*i.e.*, the side to which the reference letter *P.B.* points) is very much thinner than the posterior wall; further, that the cells forming the wall of the vesicle are of very unequal lengths, certain of the cells projecting so far into the cavity of the vesicle as to appear as small hillocks—three such hillocks are seen in the figure. The cells—especially in the thicker parts of the wall of the vesicle—are elongated columnar cells, each with two, three, or more nuclei—the nuclei lying in the long axis of each cell, and occupying that

portion of the cell lying nearest the central cavity. The cavity of the vesicle contained some protoplasmic (cerebro-spinal) fluid, which had been coagulated by the alcohol used for preserving the specimen. The presence of cilia could not positively be asserted, but the appearance of some of the cells seemed to indicate that the central cavity of the vesicle had in all probability been ciliated.

3. *Stalk or Stem of the Pineal Body.*—Tubular, slightly curved, with its proximal or central end directed slightly backwards. The epithelium lining the cavity of the stem and forming its wall is composed of columnar cells of nearly uniform length and thickness—the nuclei lie nearest the central ends of the cells, which appear in certain sections as if they were ciliated. The lumen of the stalk is in direct continuity with the cavity of the pineal body, and, like the latter, contains a little coagulated cerebro-spinal fluid.

4. *Connective-Tissue Sheath.*—A fibrous sheath (*c.t.s.*) encloses the pineal body and its stalk. Owing probably to shrinkage, a distinct space is left between the sheath and the outer surface of the pineal body (*P.B.*).

I should have stated, when describing the pineal vesicle, that the sections some distance away from the median longitudinal vertical plane appear to indicate that the lateral wall of the vesicle is plicated or pushed in at intervals, and that this infolding is not due to any shrinkage produced by alcohol.

The question naturally arises, What is the morphological signification of the thickened involuted portion of the superficial epidermis? Is it the first beginning of the future lens of the pineal eye, exactly comparable to the first step in the lens formation of each of the lateral eyes, arrested in fact at the stage which has been described by Balfour,[1] thus:—"The epiblast in front of the pit becomes very much thickened and then involuted as a shallow pit." If this median involution of the epiblast in *L. cornubica* is of any significance at all, or rather has the significance that the involution of the epiblast in connection with the lens formation of each of the lateral eyes has, then it follows, as a matter of course,

[1] Development of Elasmobranch Fishes, p. 184.

that the pineal eye is developed, so far as it goes, altogether on the vertebrate type. We have, in fact, the main constituents of the vertebrate eye, viz., the epiblastic involution for future lens, and the primary optic vesicle from the brain arrested at a very early stage of development, viz., the stage where the external epiblast has responded to the call made on it from within by the outwardly directed process (pineal evagination) of the brain itself.

It may be perhaps unsafe to conclude from the examination of a single embryo, even though it be such a lowly organised vertebrate as a shark, that this is the true explanation of the involution of the epiblast, viz., for the purpose of forming a lens; but if this involution has not occurred in connection with a lens formation, it is difficult to explain its appearance in the embryo in any other way.

On the other hand, it appears that the anterior portion of the pineal vesicle in *Anguis fragilis* is cut off to form a body resembling a lens. If this body, so separated, be really the morphological equivalent of a lens, then the pineal eye of *Anguis*, so far as the lens formation is concerned, is certainly not planned, if I may use such a term, after the vertebrate type. On the other hand, can the retina (so called) of the pineal eye be really looked upon as invertebrate in type? There are reasons, in my opinion, against the view that the pineal eye is formed and fashioned after the invertebrate type:—(1) The retina is developed directly from the brain as an outgrowth from its upper surface after the formation of the primary cerebral vesicles. (2) If Dohrn's views as to the phylogeny or origin of vertebrates be correct, then the pineal eye ought to be ventral in position, or at least we should expect the pineal stalk to arise from the under instead of the upper surface of the brain. If, then, the involution of the external epidermis over the pineal vesicle or body in *L. cornubica* be really the first step towards a future lens formation—and, as I have shown, appearances point to this conclusion—it follows that the pineal body of all vertebrates is in reality a vertebrate type of eye, arrested, however, at a very early stage (primary optic vesicle stage) in its development.

Explanation of Plate.

Fig. 1. Longitudinal vertical section (× 50), through pineal region of *Lamna cornubica*. *c.*, cartilage in process of development; *c.c.*, central canal or lumen of pineal stalk; *c.c.t.*, clear (almost transparent) connective tissue; *c.t.s.*, connective tissue sheath of pineal body; *c.t.s'.*, connective tissue sheath of pineal stalk; *E.c.t.*, ordinary embryonic connective tissue, with innumerable connective tissue corpuscles; *Ep.*, superficial epidermis; *P.B.*, pineal body; *P.P.*, pineal pit, or involution of the epidermis; *P.St.*, pineal stalk; *p.v.*, pineal vesicle, the letters are situated in the cavity of the vesicle; *s.p.*, secondary involution of the epidermis.

Fig. 2. *Ep.*, small portion of epidermis of pineal pit, more highly magnified (× 300); *m.c.*, mucous cells.

VII. *Some Further Notes on the Summer Birds of Shetland.* By Harold Raeburn, Esq.

(Read 18th March 1891.)

The following notes consist of a few additions to, and corrections on, a paper published in the *Proceedings* of this Society for 1888 (vol. ix., p. 542). The numbers refer to the figures opposite each species in that paper, and the additions to the list are given higher numbers.

3. Merlin (*Falco æsalon*).—A nest, found 12th June 1890 in Sandsting, contained four young birds a few days old. As in 1887, this was a "sham" nest—a nest of the hooded crow, begun and given up for some reason—placed on a rocky slope. The old birds were very bold, the female coming sweeping past my head within a yard or two—always, however, *from behind*—with almost invisible speed. A hand raised had the effect of instantly causing her to shoot up many yards in the air.

14. Snow Bunting (*Plectrophanes nivalis*).—A nest of this bird is said to have been obtained in Yell a few years ago, and this is given as a locality by Howard Saunders in his recent "Manual of British Birds."

23. Swallow (*Hirundo rustica*).—While at Melby on 13th June 1890, I was informed that, about three weeks previous to my visit, a number of swallows had been seen frequenting the locality for some days. None remained to nest, however.

26. Red Grouse (*Lagopus Scoticus*).—There are a few grouse

in Yell still (1890), but when the inner history of the treatment and management of these introduced birds is known, no wonder can possibly be felt at the failure to permanently establish them. The grouse was not, however, totally unknown to Shetland many years back. Dunn's "Ornithologist's Guide to the Islands of Orkney and Shetland," 1837, says, page 83: the red grouse is "occasionally seen on Ronas Hill in winter." Going back much farther, Brand, in 1701, in "A Brief Description of Orkney, Zetland, Pightland Firth, and Caithness," writing of the peregrines of Fair Isle, says: "Sometimes they'll find moorfowls in their nests." These Brand thought the peregrines brought from Orkney, but it seems possible that the grouse may have been on the way to Shetland, and had made Fair Isle a resting-place, when they were carried off by the falcons.

30. Lapwing (*Vanellus cristatus*).—On 11th June 1890, I observed two pairs near Bridge of Walls. There were none here in 1887.

37. Sandpiper (*Totanus hypoleucus*).—On 12th June 1890, I heard the familiar trill of the sandpiper for the first time in Shetland, on the shore of Burga Water in Walls. The bird was not excited, and flew right away over the loch. The female may, however, have been sitting somewhere in the vicinity. Its nest has never been found in Shetland.

47. Eider (*Somateria mollissima*).—I had the good fortune this year of being able to pay a visit to the only colony of eiders which I believe exists in Shetland, the birds being as a rule scattered in pairs up and down the coasts. This colony is situated on the summit of the Lyra Skerry, off Papa Stour, and consists of perhaps forty pairs. The Lyra Skerry is a flat-topped stack, about 30 fathoms high, and is quite perpendicular, or indeed overhanging, except a small portion at one corner, by which it is just possible to get up. The man under whose guidance I made the ascent is said to be the only native who is now competent to undertake it, as climbing has been much given up of recent years. However, one could not wish for a cooler-headed or better climber than is "Long Peter." I found the eiders' nests placed close together in

the hollows and tunnels of the huge grass-tussocks covering the summit of the stack. Most of them contained four eggs, a good deal incubated. The nests were usually well concealed, as one would certainly think would be necessary, placed as they are in the centre almost of a colony of several hundred gulls—*L. marinus* and *L. fuscus*, neither of which species is at all averse to an egg-diet. No male eiders were seen on the top of the stack, but in the sea below and on the opposite coast of Papa about fifty were observed. The only other locality where this bird is at all abundant is Linga, off Whalsay.

51. Black Guillemot (*Uria grylle*).—A somewhat extensive colony of *U. grylle* exists at the "Horse of Burravoe," in Yell, probably amounting to between forty and fifty pairs. While visiting that locality on the 18th June, every little "geo" we pulled into was enlivened and ornamented by the presence of these elegant little birds.

55. Shag (*Phalacrocorax cristatus*).—One of the most extensive "shaggeries" in Shetland is that upon the "Horse of Burravoe," and many of the nests are easily accessible from a boat. I could have collected half a hundredweight of their eggs without much difficulty. No shag's nest seen by me here or anywhere else in Shetland contained more than three eggs or young birds.

58. Black-headed Gull (*Larus ridibundus*).—I have never met with this gull in Shetland, but I am aware of one or two localities where a few pairs nest. It is by far the rarest gull in the islands.

63. Great Black-backed Gull (*Larus marinus*).—A colony of these grand birds, only second in size to that upon the inaccessible Holm of Noss, exists on the summit of the Lyra Skerry. I estimated this colony at about twenty-seven pairs, and counted ten of their nests in a line along the highest edge of the stack, besides others in different places. The estimate given in my former paper of the numbers of this gull on Noss is much too high,—there are probably less than fifty pairs this year.

64. Great Skua (*Stercorarius catarrhactes*).—On the occasion of my first visit to Shetland in 1884, I heard reports of

there being upon Foula as many as sixty pairs of this fine bird, but these I rejected as unreliable on being told by the proprietor that he understood there were only about sixteen pairs. It is evident, however, from reports this year, that the first-named figure must have been nearly correct. Though it is gratifying to know there are so many, it is impossible that this happy state of affairs can continue, unless measures are taken to protect the birds, both from the natives, who have within the last few years made it a regular practice to take almost every egg laid, and still more from parties from England and Ireland, by whom several pairs of great skuas were destroyed this year. The former practice seems difficult to stop, but a conviction and heavy fine under the "Wild Birds Protection Act," would, I am sure, have a good effect upon the second class of offenders.

The Unst colony holds its own, and has indeed increased a pair or two in the last few years, now amounting to nine pairs. On the old ground on the mainland no less than five pairs attempted to rear a brood this year, but eggs and young were taken, and old birds shot, and the others driven away, so that it is questionable if any return next year.

66. Fulmar Petrel (*Fulmarus glacialis*).—The new colony of this species on Foula seems to be increasing, and now amounts to about seventy pairs, a good deal scattered, and, according to my informant (a native), very difficult to get at; but as the Foula men, like those in Papa and Unst, have practically given up climbing, probably this inaccessibility is a good deal exaggerated. One was observed circling round the Lyra Skerry on the occasion of my visit to Papa Stour.

67. Manx Shearwater (*Puffinus anglorum*).—The principal object of my ascent of the Lyra Skerry was to ascertain if the reports in old authors on Shetland—such as Brand, 1701, and Low, 1770—of this Skerry being "inhabited by vast numbers of shearwaters" held good at the present day. Questioning the men who rowed me to the stack, I found they were totally ignorant of any such bird; nor was "Long Peter," the climber, any better acquainted with it. On reaching the summit, and making a careful examination of the place,

I was forced reluctantly to come to the conclusion that the men were right—there was not a trace of a "Lyrie" there. Nor could I find anyone who had any recollection of the bird ever having nested on the Skerry.

69. Honey Buzzard (*Pernis apivorus*).—A bird of this species was shot by Laurenson, of Lerwick, at Voe of Dale, near that town, on 10th June 1890. It was killed while picking up something on the hillside, by a long shot with one of Johns' automatic shrapnel shells, and proved to be a female in very poor plumage and condition, the stomach containing nothing but a few larvæ, which it was probably obtaining when shot. This seems a most unlikely bird to meet with in Shetland in June. The last occurrence was in 1862, as recorded by Saxby.

70. Pied Wagtail (*Motacilla lugubris*).—This species was omitted by mistake from my former paper; but in 1884 I saw a single bird near Lerwick in June, and I am informed that a nest containing eggs was found "about three years ago" at Cleekahimin Loch, about a mile from the town of Lerwick.

71. Tree Sparrow (*Passer montanus*) ?—I insert this species with a query, for I have not been able to obtain positive assurance of its occurrence; but the chirp of a sparrow, which had a nest in a ruined cottage near Sandness, seemed to me to be very like that of this species.

72. Jackdaw (*Corvus monedula*).—The jackdaw is sometimes seen in the islands in spring and late summer, but has never been known to breed there. I believe it has only one breeding station in Orkney.

73. Sand Martin (*Cotile riparia*).—This, like the fulmar, seems to be a new colonist. Howard Saunders, in his "Manual of British Birds," p. 159, says: "In 1887 Mr A. H. Evans ascertained that it nested near Lerwick, in the Shetlands, where it had not previously been known to breed."

74. Pallas's Sandgrouse (*Syrrhaptes paradoxus*).—During the great invasion of 1888, Shetland was visited by a considerable number of sandgrouse, a flock of thirty bei[illegible] observed in the vicinity of Lerwick, and numerous ot[illegible]

smaller flocks from Sumburgh Head to Unst. Two, killed in Unst on 18th May, are recorded by Mr William Evans in the *Zoologist*, July 1888, p. 262; three more were shot later in the month in the same island; and four were sent to a Lerwick stuffer from Fetlar. For further particulars, see Mr Evans's paper in the Society's *Proceedings*, vol. x., p. 117.

75. Shellduck (*Tadorna cornuta*).—It seems strange this bird should be so rare in Shetland, but the only two instances of its breeding that I am aware of occurred so far back as 1829, and again a few years later. In the former year my informant, then a boy of fourteen, shot a male and female which had a brood of young on a loch in Whalsay. He sold the duck and drake to Mr T. Edmondston of Buness, and all the young were subsequently captured, but died soon after. About three years later a gentleman of the name of Adams shot a duck, which had a brood of nine ducklings, off the coast of Whalsay.

76. Long-tailed Duck (*Harelda glacialis*).—In 1848 Wolley was given two eggs of this bird, said to have been taken in Shetland, and Saxby also obtained some about twenty years later, with the same assurance. In 1888 Laurenson, of Lerwick, got three eggs from a Conningsburgh man, which were said to have been undoubted eggs of the "Calloo." These were *unblown*.

77. Great Northern Diver (*Colymbus glacialis*).—There are constant reports of the eggs or young of this diver having been obtained in Shetland, but these invariably turn out to be those of the smaller species, the red-throated diver. Eggs were said to have been taken in Yell this year, but the usual mistake had been again made. I saw a single individual of this species, apparently fully adult, in Whalefirth, Yell, on the 19th of June.

78. Little Bittern (*Ardetta minuta*).—"About the middle of August 1883," Mr John Laurenson, of Whalsay, shot a bird in a meadow close to his croft, which his brother, Mr Laurence Laurenson, describes as being "like a haigrie (heron), but much smaller." This bird was stuffed, and lay upon the rafters of the house till this winter, when Mr L.

Laurenson, having mentioned it to me under the name of the little egret, I asked him to forward the remains. These were much dilapidated, the head and neck being completely gone, but its legs and feet, small size, and the fact of there being only ten tail feathers, showed it could be nothing else than *Ardetta minuta.* Mr J. E. Harting, to whom I submitted the specimen, confirmed my identification. This is the first time the little bittern has been recorded from Shetland, though Selby ("Illustrations of British Ornithology," p. 36) records, from Dr Fleming, one killed at Sunda (Sanda), one of the Orkney islands, in 1805.

VIII. *The Land and Fresh-Water Crustacea of the District around Edinburgh.* By THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland.

(Read 15th April 1891.)

In this and following papers I propose to give lists of the land and fresh-water Crustacea that have been obtained in the neighbourhood of Edinburgh and the surrounding district by myself, and by others so far as known to me.

The proposed limits of the district which the lists will more particularly refer to are similar to those of the late Professor Balfour's "Flora of Edinburgh"; but in respect of those species that are rare, or the known distribution of which in Scotland is limited to a few places, I may add a more or less complete record of the localities where they are known to occur. Synonyms and short descriptions of species will also be given where it seems desirable to do so, in order to render the lists more generally useful.

Although an endeavour will be made to include, as far as possible, all the species that have been observed within the proposed district, yet I am too well aware of the difficulty of obtaining full information of the records of the local land and fresh-water Crustacea that may have been published, to venture to assert that these lists will be exhaustive; but however defective they may be, if they contribute in any

way toward the preparation of a more complete and comprehensive catalogue of the Crustacean fauna of the district, they will have served a useful purpose.

In the present paper I can only overtake the Amphipoda and Isopoda, and leave the Copepoda, Ostracoda, and Cladocera for future papers.

AMPHIPODA.

GAMMARIDÆ.

Gammarus, Fabricius.

Gammarus pulex (Pennant).

1776. *Cancer pulex*, Pennant, Brit. Zool., vol. iv., p. 17.
1825. *Gammarus pulex*, Desmarest, Consid. sur les Crust., p. 266, t. 45, fig. 8.
1840. „ *fluviatilis*, M. Edwards, Hist. Nat. des Crust., p. 45, t. iii.
1863. „ *pulex*, Bate and Westwood, Brit. Sess.-eyed Crust., vol. i., p. 388.

Habitat.—Common in streams and lakes, not only within our district, but throughout these islands, and appearing to prefer localities where the water is clear and pure. So far as I know, this is the only fresh-water Amphipod in Scotland. In England, species belonging to other two genera—*Niphargus* (Schiödte) and *Crangonyx* (Sp. Bate)—are recorded from various localities, where they are sometimes spoken of as *well-shrimps*, because of their being most frequently observed in old pump- or draw-wells, such as are still to be seen in the vicinity of country villages. I have carefully examined a number of such wells in outlying districts round Edinburgh, but have failed as yet to find any trace of these Crustaceans. There is little, if any, definite information regarding the fossil distribution of *G. pulex* in Scotland. Last year, in a paper read to this Society, I recorded the occurrence of a *Gammarus* in a lacustrine post-Tertiary deposit at Kirkland, Leven, Fifeshire, which I referred doubtfully to *G. pulex*, as the specimen was incomplete. This is the only Scotch record that I know of.

ISOPODA.

(*Aquatic.*)

ASELLIDÆ.

Asellus aquaticus (Linné). **Asellus,** Geoffrey

1743. *Oniscus aquaticus,* Linné, Syst. Nat., ii., p. 1061.
1764. *L'Aselle,* Geoffrey, Ins. Paris, vol. ii., p. 672, t. 22, fig. 2.
1868. *Asellus aquaticus,* Bate and Westwood, *loc. cit.*, vol. ii., p. 343.

Habitat.—Common among weeds in ponds, lakes, canals, and slow-running streams. Very common in the Union Canal, near Gilmore Place, Edinburgh. Sir J. Dalyell speaks of it occurring "in remarkable profusion in a pond at Red Braes, in the immediate vicinity of Edinburgh." There are no records of it as a post-Tertiary fossil in Scotland.

Terrestrial (*or Æro-spirantia*).

ONISCIDÆ.

Ligia oceanica (Linné). **Ligia,** Fabriciu

1735. *Oniscus oceanicus,* Linné, Syst. Nat., ii., p. 1061.
1793. *Ligia oceanica,* Fabricius, Ent. Syst. Suppl., p. 301.
1868. ,, ,, Bate and Westwood, *loc. cit.*, vol. ii., p. 444.

Habitat.—Shores of the Firth of Forth, usually a little beyond, but sometimes within, high-water mark. Mr David Robertson has taken the young on stones at low water. I once saw a large specimen running across the footpath on the low Granton Road, east of the west breakwater: it had probably lost its way. It is a common species all round our shores, and easily distinguished from other land Isopods by the uropods being each furnished with two elongated rami. The joints of the external antennæ are numerous (18 to 19): the fourth and fifth joints are much longer than the others.

Philoscia muscorum (Scopoli). **Philosci** Latreille

... *Oniscus muscorum,* Scopoli, Entom. Carniol., p. 1145.
1802. *Philoscia* ,, Latreille, Hist. Crust. et Ins., vii., p. 43.
1868. ,, ,, Bate and Westwood, *loc. cit.*, ii., p. 450.

Habitat.—Under stones, dead leaves, etc., common. It is smooth and shining, and of a greyish-purple colour, with dark blotches arranged in an indistinctly biserial manner. It runs very quickly. The outer antennæ are eight-jointed; uropods exserted; outer ramus falciform, about twice the length of the uropods, inner ramus shorter and more slender. Another species, *Philoscia couchii* (Kinahan), distinguished from the last by its uniform lead-grey colour, by the inner ramus of the uropod being not more than one-fourth the length of the outer, and a few other points of difference, has been recorded from Banff by Thomas Edward, which is the only Scotch record I can find for that species.

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Philougria riparia (Koch).

... *Itca riparia*, Koch, in Cont. Panz. Ins. Deutschl., 162, 17.
1857. *Philougria celer*, Kinahan, Nat. Hist. Rev., iv., p. 281, pl. 22, figs. 1-4.
1868. ,, *riparia*, Bate and Westwood, *loc. cit.*, ii.

Habitat.—Under stones, usually in damp places; frequent and generally distributed. This is a small species, being scarcely an eight of an inch in length. It is of a claret-brown colour, with smooth and polished upper surface. There are three species of *Philougria* recorded as British—*P. rosea*, *P. vivida*, and the one here described. *P. rosea* has been recorded for Banff by Thomas Edward, and for Tarbert, Loch Fyne, by myself; but, so far as I know, there is no record of its occurrence for the Edinburgh district. It is usually of a rose colour, with a median white line along the dorsal surface of the body. I find no record of *P. vivida* for Scotland. The species of *Philougria* are distinguished from other land Isopods by the nine or ten jointed anterior antennæ terminating in a pencil of hairs. The following are a few of the many places where *P. riparia* has been observed — Arthur's Seat, Inchkeith, Cramond Island, St Margaret's Hope, and Largo. It was also obtained by Edward at Banff, and by myself at Rothesay. *Platyarthrus hoffmannseggii*, Brandt, a curious little white-coloured Isopod found in ants' nests, has been recorded from Banff by Thomas

Edward; it is also recorded from a few places in England, but I have not seen it. It may be easily overlooked owing to its colour and small size, and by mistaking it for the young of a common and larger species. *Platyarthrus* is worth seeking for, because of its interesting habitat. I do not know whether it restricts its association to a particular species of ant or not. It would be interesting to find out if this were so, as well as the reason why it takes up its abode in ants' nests, a habit so different from its confreres. Bate and Westwood record finding it "in the nests of the common brown garden ant at Hammersmith."

Oniscus asellus, Linné.

Oniscus, Linné.

1741. *Oniscus asellus*, Linné, Systema Naturæ, ii., p. 1061.
1868. ,, ,, Bate and Westwood, *loc. cit.*, ii., p. 468.

Habitat.—Under stones, leaves, old wood, about old walks, etc., common and generally distributed. *Oniscus* has the anterior antennæ eight-jointed, and thus differs from the next genus, *Porcellio*, which has seven-jointed antennæ. *O. asellus* is one of our most common Isopods, being found almost everywhere. Its colour is a prettily mottled slaty-blue and white, arranged in a biserial pattern from head to tail. Another species, *O. fossor* (Koch), is recorded from Banff by Thomas Edward. It is said to resemble *O. asellus* very closely, and to be distinguished chiefly by its colour, which is "of a more uniform brownish-grey," but "exhibiting the same kind of pale patches and rows of spots seen in *O. asellus*." It is said also to be more active than *O. asellus*. It is quite possible that *O. fossor* may yet be found in our district if carefully sought for.

Porcellio scaber, Latreille.

Porcelli(Latreille

1802. *Porcellio scaber*, Latreille, Hist. Nat. Crust. et Ins., vii., p. 45.
? ,, *dilatatus*, Brandt and Ratzeburg, Arzne-Thiere, t. 12, fig. 6.
... ,, *dubius* and *affinis*, Koch, in Cont. Panz., Heft 180, M. 8, and 13.
1868. ,, *scaber*, Bate and Westwood, *loc. cit.*, ii., p. 475.

Habitat.—Under stones, old wood, dead leaves, etc., almost everywhere. This is a variable species; the colour varies from a uniform dark slaty-grey to reddish and light cream colour, and it is always frequently ornamented with dark or light coloured blotches. The anterior antennæ of *Porcellio* are seven-jointed. In "Sessile-eyed Crustacea," *Porcellio dilatatus*, Brandt and Ratzeburg, is first included under *P. scaber*, Latreille, as a synonym or a variety, and then at p. 478 it is described as a distinct species. The form described as *P. dilatatus* is, as the name implies, proportionally broader than *P. scaber*, and this appears to be its chief characteristic, I am inclined to regard it as a variety of *P. scaber*. Several varieties of *P. scaber* occur in our district. A rufous or brownish-coloured variety, smaller than the typical form, is found under stones at the foot of Salisbury Crags; this I have named for the sake of reference var. *rufa*. A large variety of a light cream colour, speckled with black, was obtained at Largo, on the shore, a little above high-water mark. A common variety is one of a uniform dark slaty-grey colour, which seems to be the *P. dubius* of Koch. The more typical colour is dark slaty-grey, with splatches of yellowish or whitish scattered over it in a somewhat regular biserial manner—the yellowish or whitish colour appears as if dusted on.

Porcellio pictus, Brandt and Ratzeburg.

... *Porcellio pictus*, Brandt and Ratzeburg, Arzne-Thiere, ii., pl. 12, fig. 5.
1868. ,, ,, Bate and Westwood, *loc. cit.*, ii., p. 480.

Habitat.—About old walls and under stones, appearing to prefer dry rather than damp places. This species is easily distinguished by the peculiarly pretty markings, and by the grooved and acutely-pointed telson. The vividness of the coloration varies much; hence several species have been described by authors from their placing a greater value on the variation in colour than it deserved. Colour is always a more or less doubtful character in the definition of a species. I obtained *P. pictus* near Seafield, at the foot of a wall

bounding the south of a highway between Leith and Portobello; it was fairly common at this place. This pretty Isopod has been recorded from Banff by Thomas Edward, and from Ayrshire by Mr D. A. Boyd of West Kilbride.

Porcellio armadilloides, Lereboullet.

1853. *Porcellio armadilloides*, Lereboullet, Mem. Loc. Nat. Hist. Strasbourg, vol. iv.
1868. „ „ Bate and Westwood, *loc. cit.*, p. 485.

Habitat.—Under stones, etc., widely distributed. This is easily distinguished from the other British species of *Porcellio* by its habit of rolling itself into a ball, thus showing a close resemblance in habit to *Armadillo vulgaris.* I have obtained specimens of this *Porcellio* under stones at the foot of Salisbury Crags. I first observed it in Lanarkshire in 1885, and afterwards in the vicinity of the Rothesay Aquarium, where it was common. Mr David Robertson, F.L.S., has received specimens from Mr John Smith, Kilwinning, Ayrshire. Another species—*Porcellio pruinosus*, Brandt—described by Bate and Westwood as "one of the commonest of our wood-lice," and recorded from Banff by Thomas Edward, has not, so far as I know, been observed in our district. This may partly be due to its having been confounded with *P. scaber*, "which it closely resembles," but "from which it is at once distinguished by its more elongate form, less rugose surface, and especially by the narrowness of the tail, in which respect it approaches *Philoscia*." It is of a uniform mouse-grey colour, and if examined with a lens, is seen to be marked with white.

Armadillo vulgaris, Latreille.

1802. *Armadillo vulgaris*, Latreille, Hist. Nat. Crust. et Ins., vii., p. 48.
1840. *Armadillidium vulgare*, M. Edwards, Crust., iii., p. 184.
1868. *Armadillo vulgaris*, Bate and Westwood, *loc. cit.*, p. 492.

Habitat.—Under stones, etc., widely distributed, and probably of frequent occurrence throughout Scotland. The

localities from which it has been recorded, however, are as yet few in number. It is recorded by Thomas Edward from Banff.[1] Mr David Robertson records it from Kilwinning, Ayrshire, from which place specimens were sent to him by Mr John Smith,[2] and it is moderately common under stones at Salisbury Crags. *Armadillo* differs from all the other land Isopods by the form of the uropods, which are broad, truncate, and do not extend beyond the extremity of the pleon, so that the posterior end of the animal presents an even rounded outline. When alarmed it rolls itself into a perfect ball, the antennæ being entirely concealed. The carapace is smooth and polished, and the colour is very variable, but is usually a dark steel-grey mottled with white. Some specimens are very light coloured, while others are almost black. In "former times the *Armadillo* was highly reputed for its supposed medicinal virtues." "When dried and pulverised" these creatures were, according to the old books of materia medica, "highly celebrated in suppressions, in all kinds of obstruction of the bowels, in the jaundice, ague, weakness of sight, and a variety of other disorders. And, moreover, the wine of Millepeds—prepared by crushing these animals when fresh and infusing them in Rhenish wine—was considered an admirable clearer of all the viscera, yielding to nothing in the jaundice and obstructions of the kidneys" (see Fitch, in "Report on Noxious, Beneficial, and other Insects of the State of New York," Albany, 1855). It thus appears that sclaters have not always been treated with so much neglect as they seem to be now, though it may be questioned whether they considered the attention they received in these early days a matter for congratulation: possibly, like some of their more highly organised fellow-creatures, they prefer obscurity with its accompanying peace, safety, and contentment, rather than the condition of being "highly celebrated" and "pulverised." There is a species of millipede—*Glomerus marginatus*—that may easily be mistaken for the *Armadillo;* the carapace has apparently the same number of segments,

[1] Life of a Scotch Naturalist, p. 436 (1877).

[2] Amphipoda and Isopoda of the Firth of Clyde—Proc. Nat. Hist. Soc. of Glasg., p. 89 (1888).

the same smooth and polished surface, and in colour approaching very closely some of the darker varieties of *Armadillo.* The *Glomerus* has also the same habit of rolling itself into a ball when alarmed; but the difference between *Armadillo* and *Glomerus* is seen to be very marked by examining the number of feet in each. In the Isopods each body segment has no more than one pair of feet, whereas in *Glomerus* and other millipedes there are two pairs to each segment, so that *Glomerus* has a much greater number of feet than the *Armadillo.*

I have not had time to work up the district so thoroughly as I desired, or as it is desirable to do, and would therefore be glad of any assistance in the way of specimens or authentic notices of species of fresh-water and land Crustacea occurring within the area referred to in this paper. Such assistance will be duly acknowledged. The Isopods are quite harmless, as indeed are all the land and fresh-water Crustacea of this country at least, and very interesting in their own way when one comes to know them. It would be of much interest if the old-fashioned draw-wells, now rapidly disappearing, were carefully examined for Crustacea, especially Amphipoda, as it is possible that species of *Niphargus* or *Crangonyx* may exist in some of them.

IX. *Notes on a Collection of Echinoderms and Molluscan Shells from the Moray Firth District.* Exhibited at the Meeting held on 18th March 1891, by THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland.

The following "Notes" refer only to some of the more interesting forms exhibited.

ECHINODERMS.

Arterias hispida, Forbes. This pretty little *Asteroid* was dredged in moderately deep water (fully 18½ fathoms) at Kessock Ferry, at the entrance to the Beauly Firth, near Inverness. When living it was easily distinguished from the young of the common *Asterias* by its more spiny appearance. Several specimens were obtained.

Palmipes membranaceus, Retz. Two specimens of this species were obtained by me while on board a trawler in the Moray Firth. They were brought up in the trawl-net from a depth of 50 to 60 fathoms. Though apparently a rare species on the east coast of Scotland, it is of more frequent occurrence on the west, especially within recent years.

Hippasteria plana (Link.). This appears to be a rather common species in the Moray Firth, and is frequently captured by trawlers. The Moray Firth specimens differ a good deal from two I obtained from the Firth of Forth, especially in the length of the arms. (See notes on these, with figures of Moray Firth and Firth of Forth specimens, in the *Annals of Scottish Natural History* for January 1892.)

Luidia savignyi, Audouin. This fine specimen of *Luidia savignyi* was captured by the beam-trawl while I was on board a trawler working in the Moray Firth during March 1889. The specimen remained intact, notwithstanding the rough usage it met with, while the trawl-net was being hauled on board, and while it was being removed from the net, which was rather an unusual circumstance, judging from the accounts generally given of the fragility of this starfish. After being removed from the net in perfect condition an unforunate accident happened to the specimen, whereby it was considerably damaged. It has seven arms, and measures 17½ inches across the arms. *Luidia sarsii,* Düben and Koren, a species frequently obtained by us in the Firth of Forth between Fidra and the Bass Rock, is much smaller, and has usually only five arms.

Echinocardium flavescens (Müller). This species is not very uncommon in some parts of the Moray Firth. We have on one or two occasions obtained several specimens at a time in our small beam-trawl—especially when working off Lossiemouth. I have a specimen from near May Island, Firth of Forth, which is rather larger than those observed in the Moray Firth.

Mollusca.

Isocardia cor (Linn.). The two fine specimens of this shell now exhibited were obtained by me while on board a trawler in the Moray Firth. They were brought up in the trawl-net

from a depth of 50 to 60 fathoms, where the bottom consisted of fine mud. They were brought up, one at a time, in two consecutive hauls, and were about to be thrown overboard with the rest of the so-called refuse (or rubbish) when I rescued them. I pointed out to the men the distinctive characters of the shells, and they promised to secure any others that might turn up. Unfortunately, however, those engaged in trawling have little time, and, with few exceptions, little inclination to be troubled about natural history matters. When secured, one of the shells contained the living mollusc, the other was empty but perfect. One measures in circumference round the umbons fully 10½ inches, the other 9¼ inches. *Isocardia cor* appears to be rare on the east coast of Scotland, but a good number of specimens have been obtained during the last few years on the west coast, where it also was for a long time considered a rare species. Its more frequent occurrence during recent years may be due to greater proficiency in the use of the dredge and of the beam-trawl.

Scaphander lignarius, Linné, var. *alba*. *Scaphander lignarius* is not an uncommon shell around our coasts where the conditions are favourable to its existence, but the white variety is rather rare. The fine specimen now exhibited is one of two that were captured with our small beam-trawl while working over Smith Bank in the Moray Firth in 1889. This one measures about 2 inches in length and 3½ inches in circumference round the shortest diameter. Several smaller specimens of the same variety, as well as a number of the typical form, were also obtained at the same time.

Natica islandica, Gmelin. I have obtained a good number of specimens of this *Natica* in the Moray Firth while working there, but they were all dead shells. A few of them, however, had the appearance of being but recently dead. Perhaps the haunts of the living mollusc may, as with some other species, be rarely accessible to the dredge or the beam-trawl.

Buccinum undatum, Linné, var. *paupercula*. Several specimens of this small variety of *Buccinum undatum* were obtained at Kessock Ferry, along with *Asterias hispida* already referred to. Many of them were thickly covered, and most of them more or less so, with small barnacles (*Balanus*). Though all were

dwarfs, they varied in size to a small extent. The larger specimens measured about 2 inches in length, and one or two of these had a very aged appearance. I have obtained this variety nowhere else. The following brief discription of the locality where this dwarf variety was obtained may be of interest. Near to Kessock Ferry there is a deep hollow, where the depth of water is fully 18½ fathoms (or more correctly, as given on the chart, 112 feet). For three-quarter of a cable's length to the east and west of this there is a slight rise. What may thus be called the bottom of the hollow extends east and west, or more correctly, E.S.E. and W.N.W., and measures in length about 1½ cable (a cable's length is 608 feet). This hollow is bounded all round, except on the W. or W.N.W., by steep and, at some places, precipitous sides. On the north side there is a rise of over 100 feet in a distance of 1⅓ cable. At the eastward end there is an abrupt rise of 50 feet, but beyond this the rise is more gradual, till at about 3 cables' length from the deepest part the depth of water is 24 feet. The bottom here seems to be the top of a ridge, for eastward the water begins again to deepen. At the W. or W.N.W. end of the hollow the rise, though comparatively steep, is gradual, till at a distance from the deepest part of about 6 cables the depth of water is only 13 feet. The distance from the pier at Kessock across the water to the other landing-place is scarcely the fifth of a mile. Westward the water widens out into the extensive, though shallow, Beauly Firth or Basin, and eastward into Inverness Firth — in both of which there are extensive accumulations of mud and sand. A rapid tide runs at Kessock Ferry, the current being so strong at particular times of tide as to form a distinct "overfall," the noise of which may be heard a considerable distance away. Though mud and sand in large quantities are carried by the rushing tide from the banks in the Inverness and Beauly Firths, little or none of it seems to lodge in the hollow I have described, for when dredging in the hollow—which can only be done successfully during the "slack" of the tide—we found the bottom to be formed chiefly of rough gravel and moderate-sized boulders. The hollow appears to contain a rich fauna—especially ophytes—and would no doubt repay a careful examination.

X. *The Mammalian Fauna of the Edinburgh District.* By WILLIAM EVANS, F.R.S.E.

(Read 15th April 1891.[1])

The late Mr E. R. Alston, in the closing sentences of his Catalogue of Scottish Mammalia, published in 1880,—which, it may here be remarked, has "special reference to Clydesdale and the western district,"—pointed out to Scottish naturalists that the distribution of our mammalian-life was much in need of revision—the Shrews, Mice, and Voles (and, I would add, the Bats) being especially deserving of attention. Realising the force of this remark, I have been endeavouring during the last few years to work out in some degree of detail the distribution of these small mammals in our own neighbourhood; and my original intention was to communicate to the Society the results of my observations on these groups alone. Being, however, also in possession of a mass of data bearing on the past and present distribution of the other recent animals of the class Mammalia occurring in the district, I have thought that the present might be a fitting opportunity to lay before the Society my notes on them as well.

The "Edinburgh District," as here understood, embraces the valley of the Forth, and such parts of the adjoining areas —Tay and Tweed—as lie within easy distance, say twenty to thirty miles, of the city, the whole being capable of investigation in the course of a series of easy excursions, seldom requiring more than a day for their accomplishment. It is, in fact, practically the same area as that adopted by Balfour and Sadler in their "Flora of Edinburgh," and shown in the map which accompanies both editions of that work,—a section of country presenting a combination of physical features peculiarly rich and varied. The counties embraced are—on the south, East Lothian, Midlothian, West Lothian, and Peebles, with parts of the adjoining counties of Berwick, Roxburgh, Selkirk, Lanark, and

[1] The paper, as now printed, includes records of occurrences down to December 1891, the date of publication.

Stirling; and on the north, Fife, Kinross, Clackmannan, and a portion of Perth. Through the centre—from west to east—winds the Forth with its estuary and broad firth, into which innumerable tributary streams from secondary valleys empty their waters. Fresh-water lochs and ponds also abound. The upper part of the main valley, penetrating as it does the south-western section of the Perthshire Grampians, is thoroughly wild and alpine in character. From the rugged mountains of this north-west corner, a series of sub-alpine ranges—the Campsie Fells, the Pentlands, the Moorfoots, and the Lammermoors—with their connecting moorlands, constitute the watershed on the south; while the almost alpine Ochils, the Cleish Hills and the Lomonds, mark it on the north. Between this rampart of hills and the shores of the Forth, every variety of lowland country is to be found—fertile lands and barren commons, green meadows and furze-clad hills, breezy heights and secluded dells, with woods and plantations of deciduous trees and pines on every side. The part of the Tweed area of which we take cognisance lies largely in the pastoral county of Peebles, and consists for the most part of grassy and heather-clad hills, intersected by a multitude of glens dear to the angler. The section of the Tay area falling within our limits is mainly lowland towards the east, and highland in the west. It will thus be seen that the district, whether we contemplate it as in the natural garb of former times, or as now changed in outward aspect by the hand of man, is well fitted to be the home of a mammalian fauna rich both in species and in individuals. Reference to occurrences beyond the limits indicated above will be made when thought desirable.

From the earliest times man has ever exercised a modifying influence on mammalian-faunas, adversely affecting some species either by direct persecution or by rendering the country unsuitable to their habits, and directly or indirectly fostering the increase of others. He has, moreover, long been in the habit of importing certain species from one country or district to another, so that it is not always easy to separate the indigenous from the introduced. The more

populous a district becomes, and the more its agricultural industries are developed, the greater will be the changes on its fauna. Add to these factors the existence for many centuries of a large and influential class of landowners holding strong views regarding the preservation of game, and it will readily be understood that the district around Edinburgh was probably the first in Scotland to witness a radical change in the character of its mammalian-life within historic times. The larger predaceous animals, such as the Wolf and the Bear, which carried destruction among the flocks, and even threatened the life of the herdsman himself, would be among the first to succumb. Many species would be hunted for their skins or their flesh; others mainly for sport. The smaller Carnivora would receive further attention on account of their visits to the poultry-yard, and Hares and Rabbits because of injury to the crops. Then came the game laws—another interference with the balance of nature—accelerating the destruction of the predatory animals, and facilitating the increase of the rodents. The inordinate increase of the Rabbit led in its turn to a universal system of trapping to keep it in check, and from that day the fate of most of the remaining terrestrial Carnivora was sealed. Boece and Sibbald have put us in possession of much valuable information regarding the fauna of Scotland in the sixteenth and seventeenth centuries, but as a rule their statements are too general to be of direct interest in the present inquiry. But from the "Old Statistical Account" of the parishes we get some excellent glimpses into the state of our fauna a century ago. Even then the predatory animals had been in great measure banished to the outlying parishes, where, however, they were still not uncommon, as the following extracts clearly testify:—

CAMPSIE (STIRLINGSHIRE).—After mentioning the Badger and the Fox and their varieties, the writer of the article continues: "There are likewise (on the Campsie Fells) weasels, otters, polecats, hedgehogs, wild cats; and, of late, several martins have been seen among the rocks. . . . It may be observed, that beasts of prey are every day becoming scarcer. Till within these two years, we had a regular bred huntsman

who hunted this district; his salary was paid by the tenants, at so much per plough, which huntsman and dogs were kept and fed by each tenant in his turn" (vol. xv., p. 323).

CALLANDER (PERTH).—"Red deer come here for food and shelter in severe winters. Roes breed in our woods. Hares, rabbits, foxes, wild cats, badgers, otters, moles, polecats, weasels, and black martins, are also to be found here" (vol. xi., p. 598).

DOUNE (SOUTH-WEST PERTH).—"The wild animals here are the same as in the neighbouring parishes, hares, rabbits, foxes, badgers, otters, foumarts, or polecats. The braes on the north-east side of Cambuswallace House have been long a receptacle for badgers and foxes; but these mischievous animals are now much banished" (vol. xx., p. 49).

ALLOA (CLACKMANNAN).—"The wild animals are the same as are common to all the Low Country: hares, rabbits, foxes, badgers, otters, *foumarts*, or polecats, and *stoats*, or ermines. These last are very rare. There are no wild cats" (vol. viii., p. 645). See also Tillicoultry, where hedgehogs and weasels are added.

FOSSAWAY AND TULLIEBOLE (PERTH AND KINROSS).—"Of quadrupeds, there are foxes, badgers, otters, polecats, hares, and rabbits" (vol. xviii., p. 466).

CASTLETOWN (ROXBURGH).—"The wild quadrupeds are foxes, hares, wild cats, polecats, weasels, the white weasel, often seen in winter, hedgehogs, and Norway rats" (xvi., 76).

Many of the terrestrial species mentioned in the following pages have doubtless been inhabitants of the district from a remote antiquity. The naturalist, therefore (and I feel sure the sportsman too, if he would but allow himself to look at the matter in all its aspects), cannot contemplate without feelings of regret the extermination of such animals as the Wild Cat, the Marten, the Polecat, and the Badger, whose ancestors were the contemporaries of the Bear, the Wolf, the Wild Boar, and the Beaver, and in all probability inhabited the district while extinct Deer and Oxen, and maybe even the gigantic Mammoth, still lingered on its soil.[1]

[1] Evidence of the former existence of the Bear, the Wolf, and the Wild Boar, even within historic times, is not wanting; and remains of the Wolf have been found on the Pentland Hills; of the Beaver at Kimmerghame

As the sole object of this paper is to furnish information concerning the mammals now or recently to be found in the district, I have deemed it expedient to include in the catalogue only those species which are known to have occurred within the present century. Disregarding such as had disappeared before Sibbald's day, and also the Narwhal (*Monodon monoceros*), of which an example, obtained near the Isle of May in June 1648, is mentioned by Tulpius ("Obs. Med.," p. 376), I thus exclude but one species having anything like a substantial claim to a place in the list, namely, the Sperm Whale or Cachelot (*Physeter macrocephalus*), of which three are recorded as having been stranded in the Forth, namely, one at Limekilns in 1689, and two near Cramond, in 1701 and 1769 respectively. The fact that when the Athole herd of the so-called Wild White Cattle was broken up in 1834, about a dozen of them were secured by the then Duke of Buccleuch, and kept for a few years in the park at Dalkeith, does not entitle the animal to a place in this list, even when taken in connection with Bishop Leslie's statement that it existed at Stirling (in the royal park ?) in 1578. Those who desire information regarding the extinct forms may be referred to Owen's "British Fossil Mammals and Birds," Dr J. A. Smith's papers in the *Proceedings of the Society of Antiquaries of Scotland* (vols. viii., ix., etc.), Woodward & Sherborn's "Catalogue of British Fossil Vertebrata," and Harting's "British Animals Extinct within Historic Times."

The number of recent species (exclusive of the White Cattle) hitherto recorded on satisfactory evidence for the whole of Scotland is fifty-seven, which includes six additions to Alston's 1880 catalogue, namely, two Bats (*Vespertilio*

(Berwickshire), Linton Moss (Roxburghshire), and Loch Marlee (Perthshire); of the Elk at Whitrig Bog (Berwickshire), near Hawick, and near Selkirk; apparently also at Duddingston and near Cramond (Midlothian), near North Berwick (East Lothian), Kirkurd (Peeblesshire), Marlee (Perthshire), etc.; of the Reindeer near Craigton (Linlithgowshire), and on the Pentland Hills; of the Great Long-horned Ox or Urus at Whitrig Bog and Swinton Mill (Berwickshire), near Jedburgh, Lilliesleaf, and Linton Moss (Roxburghshire), Whitmuirhall near Selkirk, Newburgh (Fife), etc.; and of the Mammoth at Clifton Hall on the confines of the counties of Edinburgh and Linlithgow (Mem. Wern. Soc., iv., 58), and at Kimmerghame.

nattereri and *V. mystacinus*) and four Cetaceans (*Balænoptera borealis, Grampus griseus, Lagenorhynchus albirostris,* and *Delphinus delphis*). Of these, forty-eight have valid claims to a place in the present catalogue, and no fewer than forty-six of them have occurred within the Forth area. This is exclusive of Natterer's Bat, the record of which requires confirmation. The Greenland or Harp Seal (*Phoca grœnlandica*), and the Dormouse (*Muscardinus avellanarius*)—both perhaps less likely to occur—have also been recorded, but on insufficient evidence, and are consequently likewise excluded. The details of the comparison are given in the following table, which also contains the figures for the British Isles as a whole:—

Order.	Britain.	Scotland.	Edinburgh.
Chiroptera, . .	12 species.[1]	5 species.	3 species.
Insectivora, . .	5 "	5 "	5 "
Carnivora, . .	14 "	13 "	11 "
Rodentia, . . .	13 "	12 "	12 "
Ungulata, . .	3 "	3 "	3 "
Cetacea, . . .	19 "	19 "	14 "
In all, . .	66 species.	57 species.	48 species.

The number by which the Edinburgh list falls short of the British is largely made up of Bats, while the deficiency, as compared with the Scottish list, consists almost entirely of Cetaceans and Seals. The British Bats are mainly confined to England, several of them being of rare occurrence even there, so that we can scarcely hope to increase our list by discoveries in this group to the extent of more than two or three. The occurrence of any further marine Carnivora on our coasts is not at all likely; but the identification of one or two additional Cetaceans is probably only a question of time. It is therefore to the Bats and Cetaceans that we must look for any augmentation of the list. The latter group may safely be left in the hands of Sir William Turner, LL.D., F.R.S., whose investigations have already thrown so much light on this section

[1] *V. murinus, V. discolor,* and *V. dasycneme,* being in all likelihood mere importations, are excluded.

of our fauna. Should any of my readers have opportunities of obtaining Bats from any part of Scotland, they will confer a favour by forwarding specimens either to myself or to Mr Eagle Clarke of the Museum of Science and Art, Edinburgh, for examination.

On account of their timidity and more or less nocturnal habits, comparatively few of our native quadrupeds come under the notice of the casual observer; and the same causes, by rendering the observation and study of them matters of considerable difficulty, are no doubt in great measure responsible for the scanty attention paid to the class by the majority of field naturalists. With the exception of the very meagre lists in Rhind's "Excursions," illustrative of the natural history of the environs of Edinburgh, and in Stark's "Picture of Edinburgh," and of a short article which Mr Eagle Clarke tells me he has drawn up for a "Dictionary of the Forth," now being prepared by Mr D. Pollock,[1] no account of the Mammalia of the district has hitherto, so far as I am aware, been written. Records and short notices bearing on the subject are, however, by no means scarce, though scattered over a wide field of zoological and other literature. A list of the publications referred to is given at the end of the paper.

The arrangement and nomenclature followed are those adopted by Flower and Lydekker in their newly-published "Introduction to the Study of Mammals," with this exception, namely, that I begin with the Chiroptera and end with the Cetacea, instead of the reverse, the result being that the orders are presented in the same sequence as in the second edition of Bell's "History of British Quadrupeds," which is still our standard work on these animals. The following quotations from Flower and Lydekker's book are well worth bearing in mind in this connection. The authors remark, p. 84, that "In systematic descriptions in books, in lists, and catalogues, and in arranging collections, the objects dealt with must be placed in a single linear series. But by no means can such a series be made to coincide with natural affinities. The artificial character of such an arrangement, the constant violation of all true relation-

[1] Published May 1891.

ships, are the more painfully evident the greater the knowledge of the real structure and affinities. But the necessity is obvious, and all that can be done is to make such an arrangement as little as possible discordant with facts." Again (p. 85), speaking of the sub-class *Eutheria* (*Monodelphia*), with which alone we have here to do, they make the following observations:—"Their affinities with one another are so complex that it is impossible to arrange them serially with any regard to natural affinities. Indeed, each order is now so isolated that it is almost impossible to say what its affinities are; and none of the hitherto proposed associations of the orders into large groups stand the test of critical investigation. All serial arrangements of the orders are therefore perfectly arbitrary; and although it would be of very great convenience for reference in books and museums if some general sequence, such as that here proposed, were generally adopted, such a result can scarcely be expected, since equally good reasons might be given for almost any other combination of the various elements of which the series is composed."

I may here mention that for the capture of Mice, Voles, and Shrews, I use a small trap known as the "Cyclone mouse-trap"—an American patent—and find it most effective. It consists of a metal plate about two inches square, to which are attached two strong spring "jaws" of single wires, which, when the trap is unset, rest on the edges of the foot-plate, so that the whole instrument occupies very little space, thus permitting of a number being carried in the pocket without inconvenience. When exposed to damp they are apt to become rusty, which impedes the action of the springs, but this is easily obviated by the application of a little oil or vaseline. For bait I have generally used cheese, cake of any sort, or a piece of apple, but on the suggestion of Mr W. D. Roebuck of Leeds, I have lately tried powdered aniseed, and find it remarkably attractive to most of the micro-mammals.

My best thanks are due to many friends and correspondents—Mr Eagle Clarke in particular—for valuable assistance rendered in a variety of ways.

Order CHIROPTERA.

PLECOTUS AURITUS (*L.*). LONG-EARED BAT.

Though much less abundant than the next species, this Bat is widely distributed in the district, and is by no means rare. I have myself obtained it at Tynefield and Gosford in East Lothian, at Colinton in Midlothian,[1] and at Lamancha in Peeblesshire; and have seen examples (including one obtained by Mr Harvie-Brown at Dunipace in Stirlingshire), or had it reported to me, from a number of other localities on both sides of the Forth. All my captures have been made while the animals were at rest in their hiding-places, which I have invariably found to be about buildings. The Colinton colony inhabit the ruins of an ancient castle, concealing themselves in narrow holes in the masonry of the roofs of the vaults and passages. Mr G. Pow has sent me a specimen which was taken in the day-time, near Dunbar, on 10th June last. It flew against the face of its captor apparently in a dazed state, and fell helpless to the ground. At Yetholm, in June 1886, I observed one fluttering in broad daylight near an old mill in the same semi-conscious state, and might easily have captured it but for an intervening stream. Its behaviour was in marked contrast to the activity displayed by the Pipistrelle, as I have seen it under similar circumstances. As a rule this is a late flier, and hence is seldom noticed on wing. In 1793 it was recorded for Alloa ("Old Stat. Acc.," viii., p. 646).

Since writing the above, I have received from Mr Chouler, gamekeeper, Dalkeith Park, a Long-eared Bat which entered his house on the evening of 1st October, and was observed to take two flies from the ceiling of a room in which a bright light was burning. It is alive still (12th October), and is allowed out of its box for a couple of hours every evening for a flight by gaslight. When first exposed to the light, it seems rather bewildered, but very soon becomes quite lively, flitting about with the utmost confidence, examining every corner of the

[1] A specimen obtained at Yester in East Lothian, on 17th Oct. 1891, has been handed to me by Mr Bruce Campbell; and I have to thank Mr D. F. Mackenzie for another taken at Mortonhall, near Edinburgh, on 10th Nov.

room, and ever and anon resting suspended head downwards from the cornice or curtains. It delights in scrambling about the pictures, the window-blinds, and even the chairs; and often settles on the floor, where it moves with considerable rapidity (indeed, it may almost be said to run), keeping the body practically clear of the ground. A more knowing little creature I have seldom seen; and, having discovered that there is sufficient space below the room-door for it to creep through, its endeavours to overcome obstacles placed in the way of its escape are most persistent and amusing. Once it flew up the chimney, but in five minutes returned very much begrimed, of course, with soot. At the light it never flies, as moths invariably do. During flight the tail is not, as a rule, stretched full out behind (as represented in most illustrations of bats on wing), but, at about half its length, is curved downwards and forwards. From a flat surface—the table or the floor, for instance—it springs into flight without the slightest difficulty. Flies and small pieces of butcher-meat it takes readily from the hand. The inside of the mouth is quite pallid as compared with that of a Daubenton's Bat I had alive a month ago.[1]

VESPERUGO PIPISTRELLUS (*Schreb.*). COMMON BAT OR PIPISTRELLE.

Bats are familiar objects in almost every part of the district, as they flit to and fro in the twilight of summer evenings; and, of the three kinds positively known to occur, the Pipistrelle is undoubtedly by far the most abundant and generally distributed. I have examined examples from many localities; and, by its size and its style of flight, have identified it on the wing hundreds of times. Some years ago I captured about a dozen in a few minutes with a landing-net at Macbiehill in Peeblesshire, and in May 1890 I secured nearly as many with an insect-net at Gosford in East Lothian. I have also recently netted it at Duddingston Loch. For the opportunity of examining fresh specimens from the following localities, my best thanks are due to the persons whose names

[1] Captured at Cromdale, Strathspey, *vide* Scottish Naturalist, 1891, p. 190.

are given after each, namely:—Dunbar and East Linton, in Haddingtonshire (G. Pow); Yester, Haddingtonshire (Bruce Campbell); Grant's House, Berwickshire (Bruce Campbell); Stobo, Peeblesshire (J. Thomson); The Inch, Midlothian (T. Speedy); Dalmeny Park, Linlithgowshire (Bruce Campbell); Dunipace, Stirlingshire (J. A. Harvie-Brown); Broomhall, Fifeshire (W. Lumley).

With us the Pipistrelle's usual period of activity is from April till late in October,[1] but it may be seen on wing in mild weather in almost every month of the year. On New Year's Day 1883, I noticed one flying briskly about Cramond church, and two were seen in Dalmeny Park on 28th January last. Occasionally, too, it may be observed abroad at midday. In June last I watched one for fully a quarter of an hour flying in the bright sunshine at Broomhall, near Dunfermline, and was much struck with its activity, and the facility with which it evaded stones and other missiles thrown at it. It would appear that it also occasionally travels a considerable distance in search of food, for on 18th September 1884, while waiting for wild-fowl by the sandhills at the mouth of Aberlady Bay, one flew round me several times. Some of the many examples that have passed through my hands have been decidedly paler than the ordinary form, while one or two have been almost black. Their flight, as observed in my room, is more rapid and erratic than that of the last species, and instead of alighting on the cornice or curtains in an inverted position, they settle with the head uppermost, and as a rule only invert themselves when about to take flight again.

VESPERTILIO DAUBENTONI *Leisl.* DAUBENTON'S, OR THE WATER BAT.

Our knowledge of the distribution of this species in the district is still imperfect, but enough is known to show that it is, at least locally, not uncommon. Under the name of *V. marginatus*, it was recorded from Fife so long ago as 1828 by Fleming ("British Animals," p. 6). During the summer of 1869 I observed a number of Bats flitting over a still reach

[1] One was seen at Dalmeny on 7th Nov. 1891, and I saw one flying briskly near Morningside at noon on 23rd Dec. (a sunny and very frosty day).

of the Esk above Penicuik, and one which I succeeded in striking down with a walking-stick proved to be of this species. In the Edinburgh Museum there are three specimens (two adults and a newly-born young one), identified by Mr Eagle Clarke (*Scottish Naturalist*, 1891, p. 92), which were taken at The Inch, near Liberton, in July 1880 by Mr T. Speedy, who tells me they were found with many others in the hollow of an old ash. He assures me there were many dozens clustered together in this dormitory, which, however, they forsook immediately after its discovery. I have little doubt the feeding-ground of the colony was Duddingston Loch, over whose surface, on calm summer evenings, numbers of *V. daubentoni* may generally be seen.[1] On two occasions in June of the present year (1891) I was on the south side of the loch at dusk, and identified several pairs, their larger size, and habit of gliding in easy circles close to the surface of the water, serving at once to distinguish them from the Pipistrelles. In other suitable localities I have from time to time seen bats that doubtless were of this species. In the *Proceedings of the Berwickshire Naturalists' Club* (vol. ix., p. 441), Dr Hardy states—on the authority, he tells me, of the late Mr Robert Gray—that Daubenton's Bat is well known about Dunbar, a district from which, through the attention of Mr G. Pow, I have received three examples in the flesh. Two of these—male and female—were shot as they flew over a sheet of water at Broxmouth on 20th June of the present year (1891), and the third by the Tyne at East Linton four days later. The expanse of the wings in the first of these was about 9¾ inches, while in the last it was barely 9. The species has likewise been recorded more than once from Roxburghshire (*Proc. Berw. Nat. Club*, ix., p. 441; and *Scottish Leader* of 22nd June 1888). Its Scottish stronghold, however, would appear to be in the neighbourhood of Dumfries, where Mr Service tells me it is commoner than the Pipistrelle. As in the case of other Bats, July seems to be the usual time for the production of the young.

[1] Vogt, in his Natural History of Animals (London, 1887, vol. i., p. 106), says of this Bat, "Its winter quarters are in hollow trees, often pretty far from its hunting-ground."

VESPERTILIO NATTERERI *Kuhl.* NATTERER'S BAT.

This Bat is recorded as having occurred near Dalkeith, but unfortunately the circumstances are not altogether satisfactory. They are as follows:—On 28th September 1880 the late Mr R. Gray wrote to Mr Harvie-Brown in these terms—"I find a new bat to our Scottish lists in some plenty near Dalkeith, viz., *R.* [*sic*] *nattereri.*" . . . "*Nattereri* was in dozens in the hole of a tree," statements which were published by Mr Harvie-Brown in the *Proceedings of the Glasgow Natural History Society* (vol. iv., p. 303). It seems strange that Mr Gray, who was always so solicitous for the full and proper recording of rarities, should have let the subject drop here if he was convinced of the correctness of his identification. I have endeavoured to follow the matter up, but with little success. No specimen of Bat from Dalkeith, or of *V. nattereri* from any locality, can be found in Mr Gray's collections. From Mr Hope, taxidermist, Edinburgh, I learn, however, that in 1880 he had in his shop, besides those brought by Mr Speedy from The Inch, and since referred by Mr Eagle Clarke to *V. daubentoni*, some Bats from Dalkeith Park, which Mr Gray remarked were of an uncommon kind, and one of which was given to him at his request. On inquiry at Mr Malcolm Dunn, Dalkeith Gardens, he informs me that "in the spring of 1886 a large colony of bats (roughly estimated at about fifty) were discovered one sunny afternoon thickly clustered beneath the 'roan' and eave, and behind a rain-pipe" in a corner of his house. He mentioned the circumstance to Mr Gray, who expressed the opinion that they would belong to the species known as Natterer's Bat. For two or three years they frequented the same corner, but have now entirely deserted it; and though Mr Dunn has made diligent search himself in every likely place, and has kindly afforded me an opportunity for a personal examination this summer, we have not succeeded in finding their present quarters. It is possible these Bats were a colony of *V. daubentoni*; but it must be remembered that Mr Gray was well acquainted with that species, having reported its occurrence on several occasions, and that, after all, the existe

V. nattereri in the district is by no means so very unlikely, looking to its range on the Continent, and seeing it has apparently already occurred in Scotland, a specimen (an adult female) in the British Museum being labelled "Inveraray, August 1858," and identified by no less an authority than Dr G. E. Dobson ("Catalogue of the Chiroptera," p. 308). I ought to say, however, that the Duke of Argyll, from whom the specimen is said to have been received, has no recollection of the matter (letter to Mr Harvie-Brown, 24th March 1891). This record appears to have escaped the notice of Mr Alston when he drew up his paper on the Scottish Mammals, and might have been overlooked by me also, but for Mr Harting's article on the species, published in the *Zoologist* for 1889, p. 247.

To the same writer's article on the Whiskered Bat (*Vespertilio mystacinus* Leisl.) in the *Zoologist* for 1888 (p. 165), I am indebted for a clue which has enabled me to trace an undoubted Scotch example (the only one on record) of this species also. The specimen, which is in the Manchester Museum (Owens College), was captured by Mr J. Ray Hardy of that institution, who writes me as follows:—"I took the Bat you mention about four miles from Rannoch on the road to Pitlochry, early in June 1874, while sugaring for *Noctuæ*. I struck at him with my entomological net, and the cane rim caught him and knocked him down. He died in my hand." Its identity with *V. mystacinus* of Leisler was first recognised by the Rev. J. E. Kelsall, who mentioned it to Mr Harting, and this identification has been confirmed by Mr Oldfield Thomas of the British Museum, to whom the specimen has been kindly submitted by my friend Mr W. E. Hoyle, curator of the Owens College Museum. My best thanks are due to Mr Hardy for the privilege of being allowed to record these particulars for the first time. This, then, is another Bat which we may reasonably hope to discover in the district.]

Order INSECTIVORA.

ERINACEUS EUROPÆUS *L.* HEDGEHOG.

In spite of the persistent persecution to which it is subjected by gamekeepers in consequence of the occasional plunder of a pheasant's or a partridge's nest, this interesting animal is still common in all but the most unsuitable localities. Many of them come annually under my own notice between April and October—especially in those years when I happen to be much about the woods and hedgerows at night after moths. Some idea of their numbers may be gathered from the fact that a keeper on a small property a few miles south of Edinburgh kills between twenty and thirty annually. I have frequently kept Hedgehogs in confinement, but cannot say that they have always proved "interesting pets." The facility and speed with which they follow up the track of a beetle shows that they possess a very keen scent. Pale or albino examples occur at rare intervals—two (adult and young) belonging to the Earl of Haddington were exhibited at a meeting of the Royal Physical Society on 17th February 1885.

Pennant, in Lightfoot's "Flora Scotica," published in 1792 (vol. i., p. 13), says of the Hedgehog—"not found beyond the Tay, perhaps not beyond the Forth;" but the accuracy of this statement may well be questioned. Sibbald includes the "*Erinaceus*" in his "Historia Animalium in Scotiâ" (1684), but the few remarks he makes concerning it have reference entirely to its habits and uses. We may fairly assume, however, that had it then been unknown, or even very rare in Fife—a county whose animals were probably better known to him than those of any other part of Scotland—he would have made some allusion to the fact. Only six years after the publication of Lightfoot's work, the "Urchin" was included without comment in an enumeration of animals found in the parish of Dowally, near Dunkeld ("Old Statistical Account of Scotland," vol. xx., p. 472). It is also mentioned in the Account of the parish of Tillicoultry, written in 1795 (*op. cit.*, vol. xv., p. 200). Don, in his "List of Forfarshire Animals," published in 1813 ("Headrick's Agriculture of the

County," Appendix, p. 38), says: "This animal was formerly rare in Angusshire, but of late years it has appeared in tolerable plenty." From personal inquiries made in different parts of the counties of Fife, and Perth as far north as the entrance to the Highlands, I learn that it is common throughout these districts, and none of my correspondents can remember when it was otherwise. Mr Keay, gamekeeper, Murthly, can speak from his own knowledge to its abundance in that neighbourhood for over forty years. Sixty-three years ago, the limit set by Fleming to its northern distribution in Britain was the Moray Firth ("British Animals," p. 8).

SOREX VULGARIS *L.* COMMON SHREW.

Very abundant and apparently universally distributed in the district, expresses no more than the bare truth with regard to this species. Though so common, comparatively few people would be aware of its presence but for the feeble cheep and rustle in the grass, and the occasional dead body on the pathway, so seldom does the tiny creature expose his velvet coat to view. These indications of the animal's presence, however, scarcely give an adequate idea of its abundance, and it is only after we have had recourse to trapping for a time that this is fully realised. Wherever my traps have been set, from the vicinity of the seashore to the midst of the hills—whether by a stream, a hedge-bottom, or under a whin-bush; in a plantation, a garden, or an upland pasture—the Common Shrew has invariably been one of the first and most frequent captures. On the furze-clad slopes of the Braid Hills they are a perfect pest, continually occupying the traps to the exclusion of better things. In the heart of the Pentlands, too, near Loganlee, they have more than once frustrated my endeavours to obtain other kinds; and Mr Bruce, gardener, Colinton House, to whom I am indebted for examples of most of our smaller mammals, takes large numbers in and about the garden there. Correspondents in East Lothian, Peeblesshire, Linlithgowshire, and Fife, have had no difficulty in procuring me specimens. No better time for trapping them can be selected than during winter,

especially when there is frost and a sprinkling of snow on the ground; and I have captured them in the daytime as readily as at night. Though probably most active towards evening and after nightfall, the Shrews cannot properly be regarded as nocturnal animals, nor do they appear to hibernate even partially.

SOREX MINUTUS *L.* = SOREX PYGMÆUS *Pall.*
LESSER SHREW.

The authors of the last edition of Bell's "British Quadrupeds" (1872) were disposed to regard the Lesser Shrew as generally distributed in Scotland; but, while the correctness of their assumption need not be questioned, it should be remembered that it was based on very scanty data; and it is to be regretted that during the nineteen years which have since elapsed our knowledge of the animal's actual distribution in the country has received scarcely any substantial increase. By the uninitiated the Lesser Shrew is hardly likely to be distinguished from the common species; but our present ignorance of its precise range north of the Tweed is not creditable to Scottish field-naturalists.

During the winter of 1888-89, I gave the ferryman at Cramond a few traps, which he set in and about his garden, on the Linlithgow side of the Almond. Among other things, he captured three examples of this tiny quadruped, one of which—the first recorded from this district—was exhibited by me at a meeting of the Royal Physical Society on 20th March 1889. In the course of last winter (1890-91) three or four others, captured by the Messrs Campbell a little farther west in Dalmeny Park, have passed through my hands; and from what Mr M'Leish, mole-catcher, Millburn, near Corstorphine, tells me, there can be no doubt he has observed it in his neighbourhood. On 22nd November 1890 Mr Eagle Clarke captured one in the daytime on the northern slopes of the Pentlands, at Colzium, as recorded in the *Scottish Naturalist* for January last, page 36; and on 25th February Mr T. G. Laidlaw brought me another which his brother had trapped the previous day at Hallmyre, near West Linton, Peeblesshire. According to Alston ("Fauna

West of Scotland," p. v.), it is not uncommon in the Upper Ward of Lanarkshire.

As these pages are passing through the press, I learn from Mr Eagle Clarke that a specimen has been sent to him by Mr Wm. Berry of Tayfield, Newport, who captured it on 2nd November (1891) on Tentsmuir, Fife.

CROSSOPUS FODIENS (*Pallas*). WATER SHREW.

With us the Water Shrew is widely, though somewhat locally, distributed, but is nowhere abundant. I have records of its occurrence during the last four or five years in several parts of East Lothian and Midlothian; also in Linlithgowshire, Stirlingshire, Peeblesshire, and Fifeshire, and it has been observed by Dr Hardy to enter his own house at Oldcambus, Berwickshire (*Proc. Berw. Nat. Club*, viii., p. 527). Through the attention of the Messrs Campbell, I have recently had opportunities of examining several in the flesh, captured both in summer and winter in Dalmeny Park, and have found them all to be more or less of the typical form with the light underparts, which is the common form in the more inland localities also. Mr Bruce has taken it in the grounds of Colinton House, at a considerable distance from water. One found dead by my children on the path close to the Braid burn at Greenbank farm, on 10th July 1890, was of the variety with the dark underparts—the *Sorex remifer* of MacGillivray's "British Quadrupeds." I have obtained several by means of the "Cyclone" traps baited with cheese.

Alston ("Scottish Mammalia," p. 10) gives the credit of adding the Water Shrew to the Scottish list to Dr Scoular of Glasgow. As long ago, however, as 1808 it was known to Patrick Neill as an inhabitant of the Esk at Habbie's Howe, near Carlops (*vide* his list of animals and plants, contributed to the 1808 edition of Allan Ramsay's "Gentle Shepherd," vol. i., p. 269); and in 1812 Fleming, in his "Contributions to the British Fauna," published in the *Wernerian Society's Memoirs* (vol. ii., p. 238), stated that it was then "by no means rare in the county of Fife." Its presence near Abbotsford

was recorded in the *Magazine of Natural History* (iii., p. 236) prior to the appearance of Scoular's note. What Scoular (*op. cit.*, 1834, vi., p. 512) really did was to recognise the variety *remifer* for the first time as Scottish.

Since this paper was read, I have had an unusually good opportunity of studying the habits of this interesting animal in the Braid burn below Comiston farm. About 8 P.M., on 22nd May, while strolling quietly by the side of the stream, a series of ripples spreading over the water from the bank almost beneath my feet attracted my attention. In a few seconds the wavelets had vanished, and the surface of the pool was as still as before; but while I gazed into it a little creature, clothed as it were in silver, darted from the bank to the bottom of the stream, and after hastily snatching some water insects or crustaceans from a piece of wood lying on the mud, returned precipitately to its den. In this way it continued to feed for some minutes, when the sudden appearance of three others swimming out from the opposite bank was evidently the signal for play, for in an instant the four joined company and scampered up the stream after each other with astonishing rapidity, swimming on the surface or beneath it, or running on the margin with equal facility. Having gone a distance of twenty-five or thirty yards, they disappeared into a drain, but soon reappeared, and proceeded down stream, in the same manner as they had gone up, till about twenty yards below where I stood, when they disappeared a second time. In a few minutes they were out again, and so the chase went on for fully half an hour. They frequently made a squeaking noise, which seemed to me identical with that uttered by the Common Shrew. With one exception they were quite pale on the under parts. One of them now forms part of the collection of native mammals in the Museum of Science and Art; and the gambols of the survivors have been a source of pleasure to me on several subsequent occasions.

TALPA EUROPÆA *L.* MOLE.

Innumerable colonies of Moles inhabit all our cultivated lands and pastures, from the shores of the Forth to the

summits of the hills; I have myself seen their "hillocks" at fully 1700 feet on the Pentlands, and still higher on the Ochils. In the lowlands, where agriculture is at its height, the farmers wage an incessant war against it through the medium of the professional mole-catcher, but in the upland pastures it is less molested, and consequently its habits and economy can be there more readily studied. In such outlying districts, on the lower slopes of the Pentland and Moorfoot hills, I have frequently dug into the large mounds, or fortresses as they have been called, containing the snug beds of soft grass in which the animals repose during the short intervals from labour in their subterranean hunting-grounds, but cannot say that I have found the number or position of the tunnels with which these mounds are pierced, disposed with the mathematical exactitude invariably ascribed to them on the strength of Le Court's observations. Occasionally a close agreement with the well-known illustration is observed, but as a rule the departure from it is very considerable. The following figure accurately represents the plan of a "fortress," about three feet in diameter, which I dissected a few days ago on a moor behind the Dalmahoy hills. I ought to say that my attention was first directed to this want of uniformity by Mr M'Leish, mole-catcher, Corstorphine.

Under gallery communicating directly with the central chamber and the outside runs. Three escape-holes lower in the chamber are shown in dotted lines.

Upper gallery opening downwards (at the arrows) into the under one, which is shown in dotted lines.

The voracity of the Mole is well known. A year or two ago I placed one at dusk into a deep box in which a quantity of earth had stood for a considerable time. An hour after-

wards, on looking into the box by the light of a lantern, innumerable worms were observed all round the sides endeavouring to make their escape. The Mole, however, was out of sight, but his presence was indicated by slight upheavals of the soil. By next morning he had not left a worm, and so keen was his appetite that it was found impossible to meet its demands, and he died after four days of confinement. Instances of Moles taking earth-worms from the hand immediately after being captured have been related to me, and incidents of a like import are recorded in "Some Observations on the Natural History and Habits of the Mole," by the Rev. James Grierson, M.D., minister of Cockpen (*Mem. Wern. Soc.*, iv., p. 218), published in 1822.

In August last, while searching for land-shells in a birch plantation, a strange throbbing sound—a kind of thurr thurr, thurr thurr—somewhat like the purring of a cat or the distant jarring of a goatsucker, arrested my attention. Creeping cautiously in the direction whence the sound came, I perceived that it proceeded from the ground, and the moment I touched the spot it ceased. On digging into the ground a Mole's run was found a few inches below the surface, and I have not the slightest doubt the author of the sound was no other than the Mole itself.

I have obtained the young (probably ten days to a fortnight old) from the nest during the third week of May. They were then of a bluish-grey colour, very silky in appearance, and without fur.

Buff and cream-coloured varieties are not very uncommon, and from time to time afford material for a correspondence in the newspapers.

Order CARNIVORA.

FELIS CATUS *L.* WILD CAT.

Though doubtless once a denizen of all our glens and deans, wherever the banks were sufficiently rocky and clothed with woods and thickets to afford the necessary shelter, this fine animal is now quite extinct throughout the whole of the

district, and for many miles beyond it. Its extermination throughout Fife and the Lothians, with the exception of the eastern corner of Haddingtonshire, must have taken place a long time ago, but how long it is impossible to say, as no facts bearing on the point appear to have been placed on record. In some of the many suitable localities that readily suggest themselves—for instance, on the banks of the Esk, to go no farther afield—it is just possible that a few may have lingered till the opening years of the present century, but this is a mere conjecture on my part. In the cleuchs and deans of the Lammermoors, the adjoining coast of Berwickshire, and in the Border counties generally, it seems to have maintained its footing longer, and certainly existed in a few spots well into this century. The same may be said of the hills of Stirlingshire; and among the wilds of south-western Perthshire it did not finally disappear till some twenty-five or thirty years ago. In 1849 and 1874, Dr James Hardy, of Oldcambus, published, in the *Proceedings of the Berwickshire Naturalists' Club* (vol. ii., p. 357, and vii., p. 246), some valuable observations on the former occurrence of the Wild Cat in Berwickshire (and adjoining parts of East Lothian) and the other Border counties—a timely step, otherwise even the memory of it would, in all probability, have died out without notice there as elsewhere in the south-east of Scotland. What Dr Hardy did for the Border counties, Mr Harvie-Brown has done for the rest of Scotland in his excellent article on the species contained in the *Zoologist* for 1881, p. 8. Dr Hardy's main facts will be best given in his own words. In 1849 he wrote as follows:—"The Wild Cat is probably by this time considered as an extinct animal in Berwickshire. According to my information, it has not been noticed in this part of the county for at least forty years. I have, however, recently ascertained that one at least yet survives, having hitherto been secured amidst the fastnesses of our rocky coast from the unremitting persecution waged in modern times against our indigenous wild Carnivora. On the 17th of March 1849, while on a visit to the coast immediately to the east of St Helen's Chapel, I had the pleasure of seeing an individual still frequenting the ancient haunts of its race.

. . . I first remarked it on the top of one of these precipices named the Swallow Craig. . . . This was likewise the spot where, more than forty years ago, my father used to see them when they were still numerous. . . . The dark caverns, or 'coves,' of which there are several in the range of cliffs from this to Fast Castle, had the repute in former times of being tenanted by these animals. . . . By their occasional depredations in the hen-roost they were known as far westward as Dunglass, perhaps finding a retreat in the deep and wooded glen. Fifty years ago, they were exceedingly numerous in the woods above the Pease Bridge." The precipitous sea-banks between Gunsgreen and Fairneyside are mentioned as another haunt, and it is further stated that below a place named Blaikie, "there are several holes in the banks still called the cat-holes, which were the headquarters of the wild cats that prevailed there. . . . It is only within a recent period that the last of them was killed." In his 1874 article Dr Hardy adduces further evidence of the animal being formerly familiar to the country people in the Border districts. Alexander Somerville's encounter with it in the Ogle Burn, a deep dark wooded ravine running into the Lammermoors in the parish of Innerwick, as related in his "Autobiography of a Working Man," is quoted at length. Other localities particularised are "The Sting," on Upper Monynut, also in the Lammermoors, where the last "clecking" is said to have been destroyed about sixty years since; Belton Wood, where one is supposed to have been seen somewhat later; and the Press Woods, on the edge of Coldingham Moor. Place-names such as Cat-craig, now quarried away for lime, on the coast east from Dunbar; Wulcat Yett, a few miles from Jedburgh; Cat-lee Burn, in Southdean, are put forward as additional evidence; and in this connection I may also mention Wul-cat-brae on the Eye (*op. cit.*, ix., p. 15), and Cat-slack in Yarrow. In the "Old Statistical Account" (xvi., p. 76) the Wild Cat is included among the quadrupeds then inhabiting the parish of Castletown in Roxburghshire, a record which is not referred to either by Dr Hardy or Mr Harvie-Brown. In the tenth volume of the *Proceedings of the Berwickshire Club* (p. 47) it is recorded that at the

Jedburgh meeting in September 1883, "a Wild Cat (*F. catus*). shot a few years ago at Wolflee," was exhibited by Mr J T. S. Elliot; but I would ask,—Is there no likelihood of this having been a domestic cat run wild?

The "Old Statistical Account" contains abundant evidence of the Wild Cat in Stirlingshire in the end of last century. In the "New Statistical Account" of the county it is spoken of as extinct in 1842 in Campsie and Fintry, but as still existing in Strathblane, which, however, Mr Harvie-Brown is inclined to doubt (*Zoologist*, 1881, p. 15). Cat-craig and Catscleuch, near Denny, are mentioned as probable place-names in Stirlingshire. Passing to south-west Perthshire, there is no lack of evidence of its presence in many localities there during the first half of the present century; but I must refer my readers to Mr Harvie-Brown's admirable paper for the details. Suffice it to say, that two were killed near Aberfoyle about 1855; that the last obtained in the Callander district was trapped in or about 1857 in the glen of Leny, and is still preserved at Leny House; that another was killed at Cromlix, Braes of Doune, in 1857 or 1858; that about 1850 one was killed at Gleneagles; that the keeper on Balquhidder killed Wild Cats about 1855; and that in the district south of Glendochart the last was killed upon Ben More, near Suie, in 1863 or 1864.

A number of the places mentioned above are rather beyond the limits of this paper, but their bearing on the subject is sufficiently obvious, it is hoped, to justify the reference to them.

CANIS VULPES *L.* FOX.

Notwithstanding its predatory habits, the Fox is still fairly numerous, being allowed in most parts of the district a large amount of immunity from indiscriminate persecution in order that it may be hunted with hound and horn in orthodox fashion; otherwise, we may well suppose, it would have shared the fate of the other larger Carnivora, and long ere this have been practically banished from the lowlands. In the words of the writer of the article on the Fox in the Badminton Library ("Hunting," p. 63), "hunted he must be; if he is to

exist at all, it is his *raison d'être.*" At the present time there are ten packs of fox-hounds in Scotland, all located south of the Firths of Tay and Clyde. Six of them hunt the eastern division, namely—the Fife hounds, 50 couples (kennels at Harleswynd, Ceres); the Linlithgow and Stirlingshire, 35 couples (Golf Hall, Corstorphine); the Berwickshire, 35 couples (Belchester, Coldstream); the Duke of Buccleuch's, 57 couples (St Boswell's, Roxburghshire); Mr Scott-Plummer's, 20 couples (Sunderland Hall, Selkirk); and the Jedforest (Lintalee, Jedburgh). During the season 1890-91 the Linlithgow and Stirlingshire pack killed 24½ brace of foxes, as I am informed by Mr E. Cotesworth, the huntsman, who adds that the yearly average is about 25 brace. Mr W. Shore, the huntsman of the Duke of Buccleuch's pack, tells me that they usually kill about 30 brace in a season. From these statements I estimate that the six packs kill over 250 foxes per annum. Of course, a good many more are quietly got rid of in less demonstrative ways, even in the heart of the hunting areas; and in the hilly districts the keepers and shepherds openly capture or destroy all they can. Live cubs are readily disposed of at from 10s. to 15s. a-piece, to be turned out in hunting districts, chiefly in England. In the spring of 1889 a litter of five was dug out of an earth on the Pentlands above Dreghorn. A vixen and her six cubs, taken on the Peeblesshire hills in the end of April last, were sold at 10s. a-piece, while another vixen and five cubs, captured on the Pentlands above Boghall on 11th May, were disposed of at £3, 10s., being £1 for the mother and 10s. for each of her young ones.

Though, as has just been shown, this animal is by no means rare with us, it is comparatively seldom that a person not having special facilities has the opportunity of writing "Fox seen" in his diary. Still, in the course of the last fifteen years, I have observed them on many occasions (and smelt them on many more!) during my natural history rambles in Midlothian and the adjoining counties. Quite recently I had an excellent view of one on the Pentlands as it left the rocks above Swanston and trotted leisurely over the summit of Cairketton hill. When my father tenanted the farm of

Tynefield in East Lothian, a litter was reared there every year; and I well remember the delight with which we used to watch the youngsters as they played at the mouth of the earth.

In the volumes of the "Old Statistical Account," the Fox is perhaps more frequently mentioned than any other wild animal. The writer of the article on the parish of Bowden (Roxburghshire) tells us (vol. xvi., p. 239) that "much [injury] was formerly sustained from foxes, to which the furze and brushwood on the lower skirts of Eildon, both in this and Melrose parish, afford cover. Of late, however, their number has been diminished by the noblemen and gentlemen of the Caledonian Hunt and others who keep hounds." In the Account of Duddingston (vol. xviii., p. 374), it is recorded that "Foxes from the neighbouring hill or plantations sometimes invade the farm-yards." Stark, in his "Picture of Edinburgh" (6th ed., 1834, p. 322), states that it is "occasionally seen on the southern declivities of Arthur Seat hills," a locality in which I have good reason to believe it has been observed up to a much more recent date. Mr Harold Raeburn tells me that his brothers have seen one well within the city boundary, near the Dean, within the last three or four years.

Such place-names as Todholes near Balerno, Todhills near Dalkeith, etc., perpetuate the old Scotch name for the Fox.

LUTRA VULGARIS *Erxl.* OTTER.

The Otter occurs permanently or at intervals on all our rivers and larger streams, but only in very limited numbers. Without attempting to give an exhaustive list of localities and occurrences, I may mention that I have on several occasions seen their footprints or "seals" on the banks of the Biel burn in East Lothian, and only the other day by the Esk within the deer-park at Dalkeith Palace; and that, besides specimens killed in these places, I have, during the last few years, either examined examples or had their occurrence reported to me from the Tyne; the South Esk, on which one (of two) was captured near Dalhousie Castle in 1889; the

North Esk, on which one was killed near Eskbank in 1890, and another seen at Newhall five or six years since; Glencorse reservoir and Logan burn, in the Pentlands, where one was captured in 1886, and the marks of another seen the winter before last; the Tweed, between Peebles and Innerleithen, and at various other points in its course; the Almond, both near its mouth and higher up; and the Carron, in Stirlingshire. I have also quite recently seen one from near Callander, and J. Gilmour, Esq. of Montrave, informs me it is still not uncommon in Fife.

From Sir Robert Sibbald we learn that in the end of the seventeenth century, when he wrote his "History of Fife and Kinross," "the sea-otter, which differeth from the land-otter, for it is bigger, and the pile of its furr is rougher," inhabited the Firths of Forth and Tay (1803 ed., p. 114); but I am not aware that the Otter now occurs in the waters of these arms of the sea. In the volumes of the "Old Statistical Account" the Otter is frequently mentioned. For instance, in vol. xviii., p. 374, it is stated that they "used to frequent Duddingston Loch," which they have probably often visited since, for Mr Speedy assures me that not more than twenty years ago they regularly frequented the policies of Duddingston House. In vol. xx., p. 49, we are told they abounded at Loch Mahaich, near Doune. Patrick Neill, in his list of Habbie's Howe animals (1808), enters the Otter with the remark, "seldom met with" against it; and we find the fact of one being killed during severe weather in December 1812 at the farm-offices of Ingliston, a mile and a half from the Almond, considered worth recording in the *Scots Magazine* for that year (p. 892). A male killed near Stow in the end of 1831, and a female in November 1832, are recorded in the "New Statistical Account" of the parish (p. 404). Both were sent to the museum of the University of Edinburgh. The animal is also mentioned in Stark's "Picture of Edinburgh" (1834) as inhabiting the Water of Leith, "but is rare." On the whole, I am inclined to think that its status in the district now is not much worse than it was three-quarters of a century ago.

MacGillivray, in his "British Quadrupeds," 1838, p. 180, states that a pack of otter-hounds was then kept by Lord John

Scott, who "exercised" them on the streams of Roxburghshire. Since the death, about nine years ago, of Mr W. Hill, who resided for some time at Kilduff, in East Lothian, where he kept a pack, I am not aware that otter-hunting has been practised in the district, except when the Dumfriesshire hounds pay the Tweed or the Esk a visit, which they have done quite recently. Mr Chouler, keeper, Dalkeith Park, has the head of the last otter killed by Mr Hill; it was taken in the Esk on 10th October 1881.

MELES TAXUS (*Schreb.*). BADGER.

That the Badger, or Brock, as it was called, was a common animal throughout the district in olden times goes without saying. At the time the "Old Statistical Account" was drawn up—the closing years of last century—it was still well known as an inhabitant of many localities, though even then its numbers were greatly reduced; and the adverse conditions continuing to grow, its extermination in most of its former haunts was apparently accomplished by about the middle of the present century. Here and there a miserable remnant lingered a few years longer, but it is very doubtful if more than eight or nine pairs of the original stock now exist anywhere in the valley of the Forth, and these mainly in its remotest parts among the Perthshire hills, concerning which the Rev. P. Graham wrote in his "Sketches of Perthshire" (2nd ed., 1812, p. 216), "We have hares, badgers, weasels, etc., everywhere." In the valley of the Tweed it maintained its footing better, and a few favourite habitats are known to be still occupied.

In the "Old Statistical Account" of Duddingston (vol. xviii., p. 374) we read that "a solitary badger at times may provoke a stubborn chace and contest," and it is interesting to know that at the present moment a few are to be found within a very short distance of that locality, though I fear we cannot claim them as the descendants of the sturdy beasts just mentioned. I refer to the policies at Edmonstone House, where Badgers have taken up their abode for some years past, and are known to have bred on several occasions.

Unfortunately, the gamekeeper seems to think they are already too numerous, and has taken to killing them. In May of this year (1891) I saw two of them in the taxidermist's hands. It is supposed that this colony originated with a female which escaped from the stables at The Inch, where Mr T. Speedy has kept several in confinement. The Badger seen in a field near Greenend in June 1883, and mentioned in the *Scotsman* at the time, was doubtless the same animal.

Former haunts on both branches of the Esk have been placed on record. In 1808 Neill included it in his list of animals inhabiting the grounds of Newhall, on the North Esk; and the writer of the "New Statistical Account" of the parish of Borthwick, on the southern branch, informs us that while he was preparing that account (in 1839) there was a litter of young Badgers in the Chirmat, a piece of wooded hill opposite the windows of the manse. About Temple and Rosebery, in the same neighbourhood, it existed until quite recently, and the last may not even yet have been destroyed there. One which was taken alive near Temple was advertised for sale in the *Scotsman* of 25th April 1880; and a little farther east, on the confines of Midlothian and Haddingtonshire, another was trapped some sixteen or seventeen years ago at Blackshiels by Mr W. Wood, gamekeeper, who has often related the circumstance to me.

Almost every estate in East Lothian appears to have contained Badgers at one time. Mr Saunders, gamekeeper, Gosford, informs me that it is now some forty-five years since the last was killed there, and that about the same time they were on the adjoining properties of Gilmerton and Luffness, on the latter of which the last succumbed about thirty-seven years ago. From Mr R. Inglis, keeper, Tyninghame, I learn that about forty years ago he knew of two litters on that estate in each of two or three successive seasons, "but they were never allowed to live long." The last was killed there twenty-one years ago, and he is not aware of any having been seen since. There are places, however, in Binning Wood, where they may well have lingered some years longer. In May 1881 a hole once frequented by them in the grounds at Belton was pointed out to the members of the Berwick-

shire Naturalists' Club, and Dr Hardy was told that they were then preserved in Pressmennan woods, and retained a privileged home at Newbyth (*Club's Proc.*, ix., 427). The latter part of this statement is not corroborated, however, by the Newbyth keeper, of whom I have made inquiries. He has been seventeen years on the estate, and has not known of a Badger on it during that time. Pressmennan woods, on the other hand, not only were, but I have good reason to believe still are tenanted. In 1862 I saw one alive in East Linton, which had just been brought in from the Biel estate, of which Pressmennan is a part; and Mr G. Muirhead tells me he has a specimen which was captured at Salton in the spring of 1868. On the confines of East Lothian and Berwickshire, as well as throughout the latter county, they had many haunts, and in few districts have more places been named after it. We have, for instance, the Brock or Spott water, near Dunbar; the Brock-holes, a bank below Thurston Mains; Brockhole farm, on the Eye; etc. (*vide Berw. Club Proc.*, ix., pp. 17, 215, 222). Proceeding up the valley of the Tweed, we find it in Lauderdale even at the present time. During the last five or six years I have examined in the flesh about a dozen from within the watershed of the Tweed, most of them having been captured in the neighbourhood of Lauder,[1] and two in Selkirkshire. In the parish of Heriot they were present in the days of the "Old Statistical Account" (xvi., p. 51); and in the north-west of Peeblesshire one was killed at Halmyre dean about ten years ago, as I am informed by Mr T. G. Laidlaw; while on the Dolphinton estate a full-grown female—the third got there during the last two or three years—was captured on 18th April 1890, as recorded by Mr Charles Cook in the *Scottish Naturalist* for January last, page 36.

The rough braes of many a Linlithgowshire stream, covered as they then would be with natural wood and bracken, were doubtless in former times also the chosen abode of the Brock; indeed this is rendered certain as regards one section of the county at any rate, by the fact that the parish of Uphall was formerly called "Strathbrok" ("Old Stat. Acc.," vi., 543);

[1] Still common at Legerwood in 1880 (Proc. Berw. Nat. Club, ix., 242).

hence also Broxburn, the principal village in the parish. The Rev. Professor Duns informs me that when he went to reside at Torphichen in 1844, there were still a few in that neighbourhood, and that he has a skin yet which he then obtained. Lochcote was a habitat at that time, or even later, as I learn from the son of a former keeper there. Mr S. Martin, for many years keeper at Hopetoun, writes me (October 1891) that to the best of his recollection Badgers were killed there about twelve or fifteen years ago; and Mr Small, taxidermist, Edinburgh, tells me that prior to 1875 or 1876 he frequently had Badgers to stuff from Linlithgowshire. One, which I saw in Mr Small's shop, was killed on 29th September 1887, at the Witch-craig, by the Linlithgow and Stirlingshire foxhounds. In the summer of 1881 the Earl of Rosebery had a pair sent from the south of England and liberated in Dalmeny Park, but both are supposed to have wandered and been killed. In 1889, as I am informed by Mr Bruce Campbell, three others, also from the south of England, were introduced into the grounds at Dalmeny, where they have bred, and seem now to be fairly established. I saw their earth recently (April 1891), and was told that four of the animals were seen near it a short time before.

The hilly districts of Stirlingshire, on the Forth and Clyde watershed, would seem at one time to have been quite a stronghold of beasts of prey, including "two species of Badger, . . . the one somewhat resembling a sow, the other a dog"! ("Old Statistical Account," Campsie, xv., p. 322); and the abundance of the animal in Doune (on the north side of the valley) and the neighbouring parishes has already been cited (p. 88). Brocks-brae, in the parish of St Ninian's, is a Stirlingshire place-name. As might be expected, a few still exist in the mountainous country at the head of the Forth valley. On 17th April 1889, I examined a fine male from the neighbourhood of Callander, and a little farther off, in the braes of Balquhidder, one was trapped last winter.

Fife, like the other counties, had its Badgers at one time too, but they must have been rooted out many years since. In the days of my father's boyhood, some sixty years ago,

they had not ceased to exist in the woods at Dysart. Mr Gilmour of Montrave writes me that a Badger was got in Wemyss woods some years ago, but he thinks it was an escaped one. One was caught on Benarty hill "some few years" prior to 1880 (Letter from Mr C. Cook).

MUSTELA MARTES *L.* PINE MARTEN.

Once common, and with practically the same distribution as the Wild Cat, the Marten seems to have been extirpated as a resident species in the district even earlier than that animal; but, being apparently more given to wander, it has since turned up at wide intervals in localities from which it had long disappeared as a resident. Now, however, that it is being daily driven farther and farther into the Highlands, the chances of such stragglers reaching us are becoming more and more remote.

To Dr Hardy, of Oldcambus, we are indebted for bringing together what little is known of the occurrence of the Marten in the south-eastern part of the district, and I think I cannot do better than quote his remarks as printed in the *Proceedings of the Berwickshire Naturalists' Club*, vol. viii., page 527:—"In the Statistical Account of the united parishes of Cockburnspath and Oldcambus, p. 299, prepared in December 1834, the Rev. Andrew Baird reports that the Marten (*Martes Fagorum*) is said, a good number of years ago, to have inhabited the woods near the Pease Bridge. Till lately I had supposed that this hearsay had originated from some traditions of the Wild Cats that once made those woods their rendezvous; but now I think its correctness is undoubted, as Mr Peter Cowe, of Lochton, has an actual specimen of the Marten to show, and had heard of another in the very locality that I had questioned. The one preserved in Mr Cowe's collection, he writes of date 27th March 1879, 'was caught in Dowlaw dean in 1862 in a rabbit-trap. I had it alive for a week, but it would not eat. A short time, say a few weeks, after, another was caught about the Pease Bridge, but was destroyed before I heard of its capture.' Mr Kelly records that a Marten was trapped in 1848 in Lauderdale, by Mr

Scott, which was the only example known there for half-a-century. It was stuffed by Walter Simson, Lauder. This furnishes us with four Berwickshire instances of the animal."

For the rest of the district I have practically nothing to add to what is recorded in Mr Harvie-Brown's article on the species contributed to the *Zoologist* for 1881, p. 81. In the "Old Statistical Account" it is mentioned as occurring among the rocks on the Campsie Fells (vol. xv., p. 323), and in the neighbourhood of Callander (vol. xi., p. 598); and in 1838 MacGillivray described a specimen from Lanarkshire ("British Quadrupeds," p. 168). Since then examples have turned up unexpectedly in a number of places. Thus on 10th May 1870 a very fine male, which I have the pleasure of exhibiting this evening on behalf of its owner, Mr Charles Cook, was caught in an ordinary rabbit-trap on the wooded slopes of the East Lomond hill, near Falkland, Fife; and in the summer of 1873 another male was trapped in the woods at Broomhall, near Dunfermline, in the same county, by Mr Stark, gamekeeper there, in whose hands I have recently seen it. In the beginning of June 1879, Dr A. C. Stark had an excellent view of one in the fir wood behind Callander, as he informed me shortly afterwards; and in February of the same year one was killed in Glenartney. In April 1880 one which was killed in Balquhidder on the 2nd of the month, was exhibited at a meeting of this Society; and, though the fact does not bear directly on this paper, I may mention that one (a male) was caught on Urie estate, near Stonehaven, so recently as August 1888 (*Scotsman*, 1st September 1888).

MUSTELA PUTORIUS *L.* POLECAT OR FOUMART.

Seldom have the processes of extermination worked more rapidly and effectually than in the present case. Formerly abundant and generally distributed in the district, the Polecat has for many years been practically extinct, even in the more outlying localities. From the day that steel-traps came into vogue for the capture of the Rabbit, the fate of the Polecat in the lowlands was sealed.

The frequency with which it is mentioned, without any

qualifying remarks, in the volumes of the "Old Statistical Account" is excellent evidence that it was a common animal in many localities, if not indeed in all, up to the closing years of last century. For thirty or forty years more it was still well known, but its numbers had been terribly thinned in the interval, and by about 1850 it had practically ceased to exist within our limits, so that the subsequent appearance of an example here and there has always been regarded as an exceptional event, and very likely some of these have merely been escaped Ferrets. Even the memory of it is fast dying out, and comparatively few of the keepers I have questioned can give me any information regarding it. Neill, in his Newhall list (1808), and again in his Tweeddale list (1815), includes the "Polecat or fitchet" without remark, but neither Stark (1834) nor Rhind (1836) mention it among the animals to be found in the immediate neighbourhood of Edinburgh; while MacGillivray, writing in 1838, speaks of it as "of rare occurrence in the more cultivated tracts." Gamekeepers who have known some of the largest estates in Midlothian and East Lothian for more than half a century, are nearly unanimous in fixing the date of their last Foumart somewhere between 1840 and 1850. According to Dr Crombie, one was shot about a mile from North Berwick about 1860, and the only Midlothian Polecats Mr Charles Cook has a note of are one obtained on the farm of Fala Hill, and one seen at Crosswood Hill, both a number of years prior to 1880. At Edmonstone, near Liberton, one, which was afterwards trapped by the keepers, was seen by Mr James Haldane about thirty-five years ago (*vide* Mr Harvie-Brown's article on the Polecat in the *Zoologist* for 1881, p. 161). In Linlithgowshire nine were killed at Lochcote between 1838 and 1845 by the keeper, David Kerr, whose son I have recently interrogated on the subject. In 1847 Kerr also killed two at Champfleurie in the same county; and Professor Duns tells me that shortly after he went to Torphichen, in 1844, he noticed Polecats nailed to a keeper's wall. In Fyfe's "Summer Life on Land and Water at South Queensferry" (1851), the following passage occurs at page 148:—"Amongst the *feræ naturæ* of Barnbougle, or rather of Dalmeny Park,

no rambler, gifted with the sense of smell, could possibly omit the fitchet, foumart, or polecat (*Mustela putorius*), one of our finest furred animals, which we have reason to judge must be abundant in these woods, although indeed a species of fungus is found in them, which might, from its alarming smell, be apt to mislead to the belief that a polecat was near." The qualification with which the author closes his remarks will, it is to be feared, render the rest of his statement practically worthless in the eyes of most naturalists.

Mr Sam Martin, for many years keeper at Hopetoun, writes me that the last was killed there fully thirty years ago. Mr Durham of Boghead, near Bathgate (son of the late Mr Durham Weir, MacGillivray's able correspondent), has recently shown me two stuffed specimens which were captured there about forty-five years ago, and he further assured me that one was seen at a farm close by so recently as 1884. But this is not the latest record, for Mr W. H. Henderson, Linlithgow, writing to Mr Eagle Clarke in November 1890, states that at Kinneil, on the western confines of the county, on the 15th of November 1886 one ran out of a covert into a whinny mound. Mr Henderson had not seen or heard of one before in the county during a residence of thirty-five years. In the east of Stirlingshire Mr Harvie-Brown is of opinion it cannot have been common even sixty to sixty-five years ago. About 1860 several are said to have been seen on Gallowmuir by an old mole-catcher, and Mr James Stirling of Garden heard of one near there in the winter of 1879-80.

For Perthshire there are many records during the last forty years, but very few of them fall within the scope of this paper. At Leny, near Callander, one was trapped in 1855, and another in 1858, while on Lord Moray's estate above Doune one was caught about 1850. In Kinross one was seen at Turfhills about 1845, and another on Scotlandwell Moss about 1860. With regard to Fife, I have often heard my father relate his experiences when a lad in connection with the trapping of Polecats in a poultry-yard near Dysart; this would be between 1830 and 1835. According to Mr Harvie-Brown's information, none have been seen at Lathirsk since about 1860, and at Lawhill one was obtained in 1866. In

1880 one was often seen in the grounds at Falkland, and when chased it took refuge in the thick ivy of the palace walls; the keeper tried to trap it, but without success (*Zoologist*, 1881, p. 166). Mr Gilmour of Montrave writes me that he has not heard of a Polecat in Fife since he went to reside there in 1873.

Within Dr Hardy's recollection they were plentiful in the east of Berwickshire, in such localities as Dowlaw dean and the Pease dean woods, but he has not seen one "nailed up" for a long time, though he believed it had not been extirpated in the former of these localities so recently as 1880 (Harvie-Brown in *Zoologist*, 1881, p. 162). From Mr R. Inglis, keeper, Tyninghame, I learn that a brother of his killed a number at Dunglass about fifty years ago. Mr Thomas Hope, taxidermist, Edinburgh, tells me he has seen a good many killed in the neighbourhood of Jedburgh—the last about thirty years back; and in the *Berwickshire Naturalists' Club Proceedings* for 1883 (vol. x., p. 269), it is stated that the last in "Black Andros" wood in Yarrow was killed "some years ago."

MUSTELA VULGARIS *Erxl.* WEASEL.

This, the smallest of our Carnivora, is also the commonest, being still fairly numerous and generally distributed. About the farms and plantations of the Lothians it is a familiar object, preying for the most part on mice and small voles, which I have frequently watched it capturing. The actions of the Weasel when driven from its prey are most interesting, but require to be seen to be properly appreciated. On 9th January 1886, I observed one crossing the path in Dalmeny Park with something dangling from its mouth. On my throwing a stone at it, it dropped the object—a pretty little Bank Vole—and darted out of sight among the rough herbage. Taking my stand within two yards of the dead vole, I had not many seconds to wait till the Weasel reappeared, now sitting bolt upright (its heart throbbing with excitement), now plunging out of sight again, or bounding along the bank and across the road to see if the lost dainty ould not be more easily recovered from the opposite bank.

Having repeated these manœuvres for some time, it at last made a bold dash at the vole, and would have carried it off but for my interference. Occasionally, however, one sees manifestations of its cruelty that make us think of revenge. In June 1890, while sauntering along a secluded path in Gosford woods, I noticed a thrush's nest in a bush about five feet from the ground, and being curious to see what it contained, I proceeded to pull the branch on which the nest rested towards me, when out sprang a Weasel. In the nest were the mangled remains of several young mavises not more than five or six days old, on which it had feasted. Nevertheless, I would be extremely sorry to see so interesting a member of our *feræ naturæ* wiped out of our fauna. To the farmer it is an undoubted friend, and he should certainly be the last to lift a hand against it.

In 1888 Mr T. Speedy obtained from this and other parts of Scotland several hundred Weasels and Stoats for transportation alive to New Zealand, where they have been turned down in the hope that they may provide a natural remedy for the Rabbit plague in that country.

MUSTELA ERMINEA *L.* STOAT OR ERMINE.

In spite of persistent persecution, the Stoat is still by no means rare, though not so numerous as the Weasel. It is of course more confined to the hilly districts than that species, but I have met with it in the low country as well as on the hills, and in the plantations as well as in the open. When ferreting Rabbits on the wooded banks of the Esk above Penicuik, I have several times seen a Stoat bolt before the Ferret; and in the spring of 1888, while resting by the side of a fir plantation at Loganlee in the Pentlands, where numbers are trapped every season, I watched one climbing the trees and jumping from bough to bough almost as nimbly as a Squirrel. When pursued it leapt to the ground from a height of nearly ten feet, preferring evidently to make its escape on *terra firma*. The speed at which a Stoat can move along on the ground is astonishing.

During the winter months numbers are received by the

Edinburgh taxidermists for preservation. They are then in the white or ermine state. Of between twenty and thirty examined by me during the winter 1890-91, only two or three—obtained near Lauder and Gorebridge in the end of January and February—had changed colour completely; all the others were more or less brown on the upper part of the head and neck, and many of them had also a dorsal line of the same colour, but much paler, owing to a large admixture of white hairs.

HALICHŒRUS GRYPUS (*Fabr.*). GREY SEAL.

This large Seal is well known in fluctuating numbers at the mouth of the Tay, whence Professor Turner has received specimens; and though I cannot point to a record of its actual capture in the waters of the Forth, there can be no doubt it has frequently visited, if indeed it does not habitually frequent, the seaward portion of that firth as well. The discovery of bones, identified by Dr M'Bain as belonging to this species, in a kitchen-midden on Inchkeith, proves it to have been an inhabitant of the firth in former times (*Proc. Soc. Antiq. Scot.*, ix., p. 453).

So long ago as 1841, Selby recorded, in the *Annals and Magazine of Natural History*, the plentiful occurrence of the Grey Seal on the Farne Islands off the coast of Northumberland; and the late Mr Robert Walker, in an interesting article on the species contributed to the *Scottish Naturalist* for 1875 (vol. iii., p. 158), expressed the opinion that it was then the Seal most commonly met with on the east coast of Scotland, but I scarcely think this is the case now, whatever it may have been at that time. "It may be seen," he says, "all the year through at the mouth of the Tay, and along by the Carr Rock chiefly in summer. In autumn they congregate in great force in the vicinity of the banks of the Tay. These banks form a favourite resting place for them when the tide is out, as many as twenty having been counted at a time. In 1863 six specimens of this seal were caught in the salmon nets at Tentsmuir, some of them large animals, and all more or less ferocious and difficult to secure. The

largest example was estimated by the fishermen to weigh fifty stones."

Early in March 1870 an adult female, measuring 7½ feet in length and weighing 33 stones, was captured in Mr Speedie's stake-nets, at the Tentsmuir station, mouth of the Eden, near St Andrews, and secured for the Anatomical Museum of the Edinburgh University by Professor Turner, who gave an account of it in the *Journal of Anatomy and Physiology* (vol. iv., p. 270). According to Mr Walker (*Scot. Nat.*, iii., 159), another was captured along with the above; and Professor Turner states that in the previous spring two young examples, captured in the salmon-nets near Montrose, were sent to the Anatomical Museum.

At the mouth of the Tay I have myself frequently seen large Seals, undoubtedly belonging to this species. In the autumn of 1886 I had an excellent view of one gamboling with its cub on a sandbank at the mouth of the Eden. Walker, it will be observed, notes it to the Carr Rock, which therefore gives it a place in the fauna of the Forth. I well remember the large number of Seals which, twenty-five to thirty years ago, annually appeared about harvest-time in the Tyne estuary near Dunbar, many of which, I am persuaded, belonged to this species.

[PHOCA GRŒNLANDICA *Fabr.* GREENLAND OR HARP SEAL.

A young Seal obtained many years ago at the mouth of the Firth of Forth was somewhat doubtfully referred by MacGillivray to this species ("British Quadrupeds," 1838, p. 209). It does not appear to have been preserved, so that we have now no means of judging of the correctness of his surmise. In former years, when this Seal was more abundant in its northern habitats, it is not improbable that one or two may have occasionally wandered to our shores, but as our information at present stands, we would scarcely be justified in giving the species a full place on our list.]

PHOCA VITULINA *L.* COMMON SEAL.

Although not so abundant as formerly, this is still a common animal in the Firths of Forth and Tay, where it

may be seen all the year round. Off the southern shores of the Forth, from Dunbar to Prestonpans, I have watched them on many occasions, and I recently saw one living in confinement which had been taken in the salmon-nets at Dalmeny. But their headquarters appear to be on the north side of the firth westward from Aberdour, and in the bay above North Queensferry within the estuary proper. When boating among the islands off Aberdour during the summer months, I have invariably found them present, occasionally in considerable numbers. On New Year's day 1886, I discovered a small one, apparently asleep, on a rock in Dalgetty Bay. It being low water at the time, I was able to walk within 12 to 15 yards of the animal, whose slumbers I rudely broke by a thump on the ribs with a good-sized stone. Instantly bending itself like a bow, with the central part alone resting on the rock, it gave a sudden jerk and sprang into the water. Once there it evidently considered itself safe, and, reappearing about 20 yards farther off, gazed in astonishment at the cause of the sudden interruption.

The Du Craig, a small islet off Rosyth Castle above North Queensferry, has long been noted as a favourite haunt of the Common Seal (*vide*, for instance, Fyfe's "Summer Life on Land and Water at South Queensferry," 1851, p. 270). When visiting this rock on 5th July 1884, for the purpose of identifying the terns which annually resort to it to breed, I noticed a number of Seals, some of which followed our boat at close quarters for a considerable distance.

The following extract from the Accounts of the Lord High Treasurer of Scotland in the days of James IV., shows that Seals then, as now, frequented the Isle of May, to which that monarch was a frequent visitor. "1508 [8 Mar.] Item, that day to the heremyt of Maij that brocht ane Selch to the King . . . . xiiijs." (Stuart's "Records of the Priory of the Isle of May," p. lxxix). Sibbald, in his "History of Fife and Kinross" (1710), mentions the Seal several times. Many of the "Phoca, or Vitulus marinus, the Seal: our fishers call it a Selch," he says, "frequent the coasts of these two firths" (*op. cit.*, ed. 1803, p. 114); and, speaking of the Isle of May, he remarks that "many Seals are slain upon

the east side of it" (*ib.*, p. 101). Quoting from a charter of David I. to the Monastery of Dunfermline, Sibbald further shows that Seals were a matter of trade in the twelfth century (*ib.*, p. 295).[1] In Stark's "Picture of Edinburgh" (1834), p. 322, we are told that "in the Firth of Forth the Seal (*Phoca vitulina*) is continually showing its black head;" and in the "New Statistical Account" of Alloa (1840), it is recorded that Seals "are constant inhabitants of the Forth here."

CYSTOPHORA CRISTATA (*Erxl.*). HOODED OR BLADDER-NOSE SEAL.

One of the very few authentic instances of the capture of this inhabitant of high latitudes on the British coasts, is that of a young male taken opposite St Andrews on 22nd July 1872, and of which the late Mr Robert Walker, of the University of that town, gave a detailed description at the time in the *Scottish Naturalist* (vol. ii., p. 1). It was about 4 feet in length—47 inches was the exact measurement—and "when discovered it was reposing, near low-water mark, on the top of one of the ledges of rock that stretch out into the sea."

It has been suggested that the "sundry fishes of monstrous shape," mentioned by Boece, "with cowls over their heads like unto monks, and in the rest resembling the body of man," whose appearance in the Firth of Forth in 1577 caused such consternation among the superstitious folks of those days, may have been Hooded Seals.

Order RODENTIA.

SCIURUS VULGARIS *L.* SQUIRREL.

At the present time the Squirrel is a common animal throughout the length and breadth of the district; indeed it is safe to say there is scarcely a wood of any extent in any part of it which does not contain at least a few. Yet it was

[1] The words of the charter are:—"Et de seliches qui ad Kingornum capientur, postquam decimati fuerint; concedo ut omnes septimos seliches habeant."

not always so, for apparently the Squirrel was either entirely absent or very scarce in the south of Scotland when introduced at Dalkeith in the latter part of last century. Mr Harvie-Brown, who has made the history of the animal a special study, and, as the outcome of his investigations, has published a long and interesting paper in the *Proceedings of the Royal Physical Society* (vols. v. and vi.), considers there is no evidence of its prior existence in this section of the country, and lays little stress on the statement in the "New Statistical Account" of Berwickshire (1841, page 299), that "the Red Squirrel is said to have been at one time a denizen of Dunglass woods, in Cockburnspath parish." I cannot help thinking, however, that it must at one time have been indigenous in the Lowlands, and have gradually retired to the Highlands in consequence of the destruction of the ancient woods and forests; otherwise, what are we to make of Sibbald's statement ("Scotia Illustrata," 1684),—"In Meridionalis Plagæ Scotiæ Sylvis reperitur" (It is found in the woods of the southern part of Scotland)? There can be no doubt, however, that the south-eastern counties owe their present stock very largely, if not entirely, to the introduction of a few, first at Dalkeith Park about 1772, and then at Minto in 1827. The history of these introductions, and the subsequent spread of the species, are so very fully set forth in Mr Harvie-Brown's paper, that I need only refer to a few of the leading facts, and draw attention to one or two records which he does not allude to.

The current belief, from the time of the "Old Statistical Account" till now, is that Elizabeth, Duchess of Buccleuch (the present Duke's great grandmother), introduced Squirrels from England about 1772 to the menagerie which her husband (Duke Henry) then kept in the park at Dalkeith. Gaining their liberty either accidentally or by design, and finding a congenial home in the woods of the park, they increased with astonishing rapidity, so that in the course of the next twenty or thirty years they had spread eastward into Haddingtonshire and westward over the entire valley of the Esk. Here is what the minister of Pencaitland, in East Lothian, had to say of it in 1796: "The young woods on

the estate of Fountainhall, it has been observed, have of late suffered much from Squirrels, which were introduced some years ago at Dalkeith, and have spread to this neighbourhood. They have attacked the Scotch firs in the proportion of about one in twenty, and almost every larix and elm. Already many of each of them are killed. If the harm they do in other places be as great, and be progressive as they multiply, this intended improvement will be unfortunate" ("Old Statistical Account," vol. xvii., p. 36). In 1791 it had "lately arrived at Penicuik from the menagerie of the Duke of Buccleuch" (*op. cit.*, vol. i., p. 132); and in 1795 the writers of the account of the parish of Glencross, of whom Professor J. Walker was one, record that "the Red Squirrel has become extremely common of late years. In this neighbourhood, the woods abound with them, and they are pretty numerous at Woodhouselee" (*op. cit.*, vol. xv., p. 439). Then in 1808 Patrick Neill records it for Newhall, which is much farther up the Esk, and where it had already given its name to the Squirrel's Haugh, adding, "introduced from England, but now common" ("Gentle Shepherd," i., pp. 270 and 279); and it is evidently the same naturalist who, in Pennecuik's "Tweeddale" (ed. 1815, p. 103), states that the animal was "Introduced on the North Esk, from England." This looks not unlike a separate introduction, but it may, of course, merely refer to the Dalkeith one. In the course of the next few years it had spread through Linlithgowshire into Stirlingshire, and even beyond the Forth into Clackmannan and South Perthshire,—where no doubt colonists from the north were met,—so that when the "New Statistical Account" was drawn up it was frequently alluded to. The colonisation of Fife seems to have been entered on somewhat later, and to have proceeded more slowly. Peeblesshire is also supposed to have been colonised from Dalkeith (the doubt expressed in Chambers's "History of Peeblesshire," Appendix, p. 525, is scarcely worth considering); but Roxburghshire, Selkirkshire, and Berwickshire are thought to have been stocked mainly from Minto, where several which the gardener there had obtained from Dalkeith in 1827 shortly afterwards made their escape. According to Dr Hardy, it appeared in Penmanshiel wood,

in the east of Berwickshire, as early as 1830 or 1831; and 1838 or 1839 is the date fixed by Mr Kelly for their first appearance in Lauderdale, where they rapidly increased, and necessitated an order for their destruction in 1849, in consequence of the damage they were committing among the young fir trees (*Proc. Berw. Nat. Club*, viii., p. 527).

The Squirrel has sometimes been accused of killing birds, merely because their bones have been found in its dreys, but as well might I argue that it occasionally kills sheep, because I recently observed one gnawing a shank-bone of that quadruped. Observing the little animal working with something on the ground in a large fir wood, I walked towards it, when it at once scampered up a tall clean-stemmed tree, holding the object in its mouth. Having reached a branch about fifty feet from the ground, it sat down, and, grasping the prize between its fore-paws, began nibbling at the end of it. On my striking the branch with a stone, it dropped the object, which, to my surprise, was a sheep's shank-bone, measuring fully seven inches in length. A large hole had already been gnawed in the thick end of it.

According to Bell, the young are born in the month of June, and MacGillivray's statement is to the same effect, but I am inclined to think April is the more usual time, and that a second litter may frequently be born in the latter part of summer. Unfortunately I can only give one exact date, namely, 23rd April, on which day a nest containing several young Squirrels was discovered. At least two other instances, however, of young in April have come to my knowledge; also one in August. As to the supposed hibernation of the Squirrel, I can only say that I have seen them frisking about in every month of the year.

[MUSCARDINUS AVELLANARIUS (*L.*). DORMOUSE.

In 1838 MacGillivray wrote, "This species . . . has not hitherto been satisfactorily proved to exist in Scotland, although it has been reported to me to occur near Gifford in East Lothian" ("British Quadrupeds," p. 236). No evidence in support of this statement has ever been forthcoming, and we must therefore conclude that his informant was in error.]

ARVICOLA AMPHIBIUS (*L.*). WATER VOLE.

This well known and, for the most part, harmless creature, is abundant on the banks of all our streams, ditches, and ponds, where it may be constantly seen and its habits studied without difficulty. Any kind of country appears to suit it, so long as there is water at hand. It is equally at home, for instance, by the marshes on the coast, the ditches bordering the corn-fields, the ponds in the midst of plantations, or the burns meandering among the hills. It reaches a considerable elevation, for in May 1887 I saw a buzzard capture one on the hills above Loch Skene. When the bird had devoured it, I went to the spot and picked up the skin, which was so little damaged that it might very well have done for making into a stuffed specimen.

Occasionally this animal takes up its abode in our gardens, where it makes "runs" and commits considerable damage, destroying even shrubs and young trees by gnawing their roots. Several instances of this have come to my own knowledge. In March 1887 I obtained an old male from Dr Ronaldson's garden, Bruntsfield Place, Edinburgh, which had almost killed several bushes and young apple-trees by cutting off their roots. I handed the Vole and a specimen of its work to Professor Duns, who recorded the facts in a note which was published in the ninth volume of the *Proceedings of the Royal Physical Society*, p. 325. In a previous note bearing on the habits of this species (*op. cit.*, vol. v., p. 352), Professor Duns recorded the capture of another in an Edinburgh garden, where it had been feeding on beetroot.

The Water Vole is sometimes accused of killing young birds, and I am not prepared to affirm that it never does; but I believe such an occurrence must be very exceptional. On Luffness marshes, where the animal is very abundant, I have seen a young redshank lying half-eaten at the mouth of one of their burrows,—no proof, however, that the Voles had killed it. My explanation is that, finding the bird dead, they were tempted to eat it, in the same way that Field Voles will devour a dead companion.

In the spring of 1890 a colony established themselves in a piece of rough, sandy ground by the public road near where a small stream enters the sea at Gosford Bay. For fully a month I passed the spot twice a day, and was much struck with the want of fear which they displayed, several always sitting unconcernedly about the entrances to their burrows while vehicles and pedestrians moved past within a few yards; indeed, so little notice did they take of people passing by, that Mr Eagle Clarke knocked one over with his walking-stick.

The black variety—the *Arvicola ater* of MacGillivray—is not common, but occurs from time to time in every county. I have notes concerning examples taken in Berwickshire, Roxburghshire, the three Lothians, Stirlingshire, Perthshire, and Fife. The Fife specimens, which as usual were small animals, were captured near Colinsburgh, where the form appears to be not uncommon. In the Highlands it is decidedly more numerous than in the Lowlands.

ARVICOLA AGRESTIS *De Selys.* FIELD VOLE.

The Field Vole is abundant and generally distributed from the coast-line to the most inland localities, living among rough grass in meadows, young plantations, moors, and hill-pastures alike. Formerly I was in the habit of looking upon it as everywhere more abundant than the next species, but this view has not been borne out by my recent investigations. In the immediate neighbourhood of Edinburgh, for instance, I have trapped three *Glareolus* for one of *Agrestis,* and I am inclined to think that the former is likewise at the present time the commoner animal in many other parts of the fertile belt of country bordering the shores of the Forth, and probably the same may be said of the valleys of the Tay and the Tweed. But the moment we reach the hills and the moorlands, *Agrestis* becomes the commoner, and is in many districts apparently alone present. A number of years ago, when my home was at Macbiehill in Peeblesshire, it was very common there, and Mr J. Thomson, who has sent me a specimen, tells me it is abundant about Stobo in

the same county. Within the last two years I have obtained very typical specimens from Aberlady, Dalmeny, Colinton, Dreghorn, the Braid hills, and the Pentlands. On the southern slopes of the Pentlands, near the farm of Boghall, there is a young fir plantation filled with tussocks of the *Aira cæspitosa* grass, and here *Agrestis* is in its element, burrowing under the tussocks, whose tender shoots supply it with abundance of food during winter and spring. By setting a few traps in the little "seats" at the mouths of the burrows, I have had no difficulty in capturing the inmates. Beds of *Juncus* also form favourite haunts. Though they certainly remain more at home in winter than in summer, they do not in any sense hibernate, and while they probably move about more or less at all hours, I am inclined to think they are most active towards evening. In winter afternoons I often see them about the entrances to their burrows. Owls and kestrels (to say nothing of weasels) of course destroy great numbers. Besides finding their remains in the "castings" of these birds, I have seen in the nest of a long-eared owl near Balerno several of this and other small rodents lying ready for consumption.

In the Southern Uplands the Field Vole, or Hill Mouse as it is there often called, at times multiplies to such an extent, and with such astonishing rapidity, as to assume the character of a veritable plague. The year 1876, for instance, was a memorable example. For a year or two previously they had been observed steadily increasing, no doubt in large measure owing to a succession of favourable winters, and reached a climax in 1876, when the pasture on whole hill-sides was destroyed by them. The country about Hawick seems to have suffered most. In the Borthwick-water district alone 10,000 acres of pasture were wasted to a greater or less degree—the damage being estimated at not less than £5000. A full account of this plague was prepared by Sir Walter Elliot for the *Proceedings of the Berwickshire Naturalists' Club* (vol. viii., p. 447). Sir Walter speaks of the present species only, but I imagine that in some localities at any rate the Bank Vole, which Dr Hardy (who identified specimens) tells us in a subsequent volume of the *Proceedings*

(x., p. 278) was in great numbers at Faldonside in 1883, would also be present.

Since writing the above in April last, I learn that the Border counties are again the scene of another Vole plague. The subject is thus referred to in an article in the *Scotsman* of 12th November:—"Some three months ago reference was made to what is spoken of and felt as the mice plague on the Borders, and which was then affecting to a serious extent most of the farms in the western portion of Selkirkshire and the adjacent districts of Dumfries and Roxburgh shires. Since then there has been no mitigation of the pest, but on the contrary a great extension of the area over which it is spread, and an intensifying of its ravages. From inquiries made within the past week, it has been ascertained that the outlook, as the winter approaches, becomes more and more serious. The vermin have multiplied greatly during the summer, and they now swarm in numbers which defy computation. The high-lying farms on the western border of Selkirkshire seem to be suffering most. . . . Throughout the summer, grass and other herbage chiefly were preyed upon. The grassy farms have suffered, and are suffering most. The vermin do not seem to live on the lea grasses or dry hill-sides; the grassy bogs and white bent are the places where they abound most. Wherever the ground is what the shepherds speak of as 'not bare,' there they swarm in greatest numbers. They nibble and gnaw the long grass close to the ground, and the land is rendered altogether valueless for winter and spring feeding. Hundreds of acres of the best pasture land on many farms have thus for the present been totally destroyed, and whole hill-sides wear a blasted and desolate aspect, the ground being perfectly riddled by their holes and runs. In the autumn months hayricks were infested by the mice in countless numbers, and the hay has in many cases, as one observer expressively says, been minced into perfect chaff. Then the corn-stooks swarmed with them, as many as four or five nests being frequently found in a single sheaf. Now they have found their way to stackyards, barnyards, and outhouses, and are doing vast damage there. Even in gardens they are destroying the roots of plants and flower bulbs. . . . To

exterminate them seems beyond the province of hope. Burning the ground where the destruction is greatest does no good, says one, they fly to their holes and ere long again appear; heavy rain does not drown them; some people, remembering how they disappeared after a similar but not so serious a plague about fifteen years ago, believe that a fall of slushy snow would kill them [a 'black' frost would have more effect], but slushy snow does not suit sheep, and such a remedy for the plague would of necessity involve great loss of stock. In some places more than the ordinary number of cats are kept, and these are credited with doing good work on the farmers' side. It is remarked that owls and hawks have been increasing all over the infected region; one informant mentions that in his locality the latter are as plentiful as crows; and in such an emergency all are gladly welcomed. But all that is being done in these various ways does not tell in any appreciable degree on the myriad swarms."

Desiring to see a few examples from different elevations, I applied to Dr J. R. Hamilton, of Hawick, who very kindly procured me a dozen from that neighbourhood. They were captured at various altitudes, from about 600 feet to close on 1000 feet above sea-level, and belonged without exception to the present species, *Arvicola agrestis.* One was cream-coloured (with black eyes), and the rest gave me the impression of being a shade darker than specimens I have examined from other localities. In acknowledging receipt of a couple I sent to the British Museum, Mr Oldfield Thomas, while unable to say that they present any peculiar features, adds that there can be no doubt about the species. My children have appropriated half a dozen of them as pets, and I don't think I ever before saw a wild animal take so readily to confinement. They exhibit practically no fear, and will sit on the hand for any length of time, regaling themselves on apple parings, bread soaked in milk, etc. The tender shoots of grasses they are very fond of, using the fore feet singly after the manner of a hand to bring the stems to the mouth and hold them in position. They show no desire to harm each other when in life, but the body of a dead companion is soon attacked and devoured. Furnished with strong chisel-like

teeth, they are capable of making their escape in a very short time from almost any kind of wooden box. When disturbed or hungry they make a half grumbling, half squeaking noise, very much the same as guinea-pigs do, only not so loud.

The dimensions of this animal vary considerably, and do not appear to me to be always accounted for by age and sex. The following are a few measurements taken by myself from specimens captured in the months of January, March, and November:—

	♂	♂	♂	♀	♀
Length of head and body,	3·9 in.	4·0 in.	4·5 in.	3·75 in.	3·5 in.
Length of head alone, .	1·2 „	1·2 „	1·4 „	1·2 „	1·1 „
Length of tail, . .	1·2 „	1·15 „	1·3 „	1·05 „	1·0 „

Arvicola glareolus (*Schreb.*). Bank Vole.

My recent investigations among our micro-mammals have convinced me that the Bank Vole is common all along the valley of the Forth, and in all likelihood the same may be said of the Tay and the Tweed. It appears, however, to be in a great measure confined to the fertile belts in the lower parts of the valleys, becoming much scarcer or altogether absent in the upland districts, exactly where the Field Vole becomes most abundant. In the immediate neighbourhood of Edinburgh I find the Bank Vole the commoner of the two, and I am inclined to think this has long been the case, but there is no evidence to point to, as the earlier writers seldom distinguished between the two species—indeed, MacGillivray is the only one who does so with regard to the Forth area, and the only locality he mentions is near Bathgate, in the county of Linlithgow, where specimens were procured by Mr Durham Weir ("British Quadrupeds," 1838, p. 272). The only other Scotch locality given by MacGillivray for the animal is near Kelso, and on 6th May 1840 Dr Johnstone announced its

occurrence at Mayfield in Berwickshire (*Proceedings of the Berwickshire Naturalists' Club*, vol. i., p. 214). Faldonside is another Border locality, in which, according to Dr Hardy (*op. cit.*, x., 278), it was abundant in 1883. During the last four years I have observed it at Rosetta and other places near Peebles, and Mr John Thomson has sent me one from Stobo, a few miles higher up the Tweed, where he tells me it is common about potatoe-pits during winter.

Seeing so little has been recorded of the Bank Vole in the neighbourhood of Edinburgh, the following facts from my own experience may not be without interest. In January 1886 I obtained one which had been killed by a weasel in Dalmeny Park, close to the Cramond ferry, and I then learned from the ferryman that the animal was common in the park, and did considerable damage during winter and spring to carnations and other flowering plants in his garden. The same complaint is made against it by Mr Bruce, gardener, Colinton House, from whom I have received many examples, and Mr Mackenzie, factor, Mortonhall, has also found it very troublesome in his garden of late. From Cramond I have obtained a number of very typical specimens, one of which I exhibited at a meeting of the Royal Physical Society on 15th January 1890. Since then I have trapped numbers in the following localities, namely, by the banks of the Braid burn below Comiston, on the Braid hills, by the roadside between Fairmilehead and Kaimes, at Dreghorn, at Lothianburn, and on the south side of the Pentlands, both by the roadside beyond Hillend and in the young plantation on the hill-side at Boghall. I have also obtained it at Gosford, in East Lothian. A bank on the sunny side of a wall is a favourite habitat, especially if well clothed with tussocks of cock's-foot grass (*Dactylis glomerata*). They may be seen sitting near the entrances to their burrows at all hours of the day, but the afternoon seems to be the time of their greatest activity. On a winter's day, if the sun has been bright, I can always depend on seeing numbers towards sunset feeding by the roadside which skirts the southern confines of Mortonhall grounds. As the spring advances they may be observed climbing the briars, thorns, and sapling elms, and nipping off the expanding leaf-buds.

The following are a few measurements taken from examples captured in January and March:—

Length of head and body,	3·2 in.	3·25 in.	3·25 in.	3·2 in.	3·5 in.
Length of head alone, .	1·0 ,,	...	...	1·1 ,,	1·1 ,,
Length of tail, . .	1·45,,	1·5 in.	1·45 in.	1·6 ,,	1·4 ,,

MUS DECUMANUS *Pall.* BROWN RAT.

The Brown Rat is only too well known wherever human habitations and industries have been established, finding a congenial home alike in town and country. It seems to be living more in the open fields now than formerly, and at times it increases to such an extent in certain localities as to become a serious agricultural pest, as has recently happened in East Lothian and the adjacent parts of Midlothian, where meetings of the farmers have been held to discuss the situation, and if possible devise a remedy (see numerous communications in the *Scotsman* during December and January last).

The first appearance of the Brown Rat among us does not seem to have been placed on record, but we may safely assume that the ports of the Firth of Forth were among the earliest localities in which the immigrants obtained a footing in Scotland; and we shall probably not be far wrong in referring the event to about the middle of the eighteenth century. By the beginning of the present century it was apparently only too common almost everywhere.

Walker, writing probably between 1764 and 1774, says of it, "First brought, as is reported, into Scotland in ships from Norway. Wherever it set up its abode, it entirely put to flight the *Mus rattus*."[1] The following interesting account of its progress from Selkirk to the upper valley of the Tweed, as narrated in the "New Statistical Account" of the parish of Newlands (Peeblesshire, 1834, p. 137), is worth repeating "Zoology:—Under this head may be noticed the brown, or Russian, or Norwegian rat, which a good many years ago invaded Tweeddale, to the total extermination of the former black rat inhabitants. Their first appearance was in the

[1] "Primum delatus, ut fertur, in Scotia, navibus e Norvegia. Ubicunque sedes suas figit, Murem *Rattum* penitus fugat" (Mammalia Scotica, p. 498).

minister's glebe at Selkirk, about the year 1776 or 1777, where they were found burrowing in the earth, a propensity which occasioned considerable alarm, lest they should undermine houses. They seemed to follow the courses of waters and rivulets, and, passing from Selkirk, they were next heard of in the mill of Traquair; from thence, following up the Tweed, they appeared in the mills of Peebles; then entering by Lyne Water, they arrived at Flemington-mill, in this parish; and coming up the Lyne they reached this neighbourhood about the year 1791 or 1792." Neill includes it without remark in his Newhall list (1808).

MUS RATTUS *L.* BLACK RAT.

Prior to the invasion of its haunts by *Mus decumanus*, the Black Rat infested all our towns and villages, and doubtless farm-steadings too. It seems to have been quite unable to live in competition with its more vigorous congener; and simultaneously with the rapid increase of the one, there took place a corresponding decrease of the other—cause and effect unquestionably—so that, by the early years of the present century, *Mus rattus* had practically ceased to exist in the coast towns, and a few years more sufficed to carry the extermination to its inland haunts as well. At the present time we have no proof of its existence on shore, though it is not improbable that a few now and again attempt to establish themselves in Leith and other ports, seeing they are known to exist in considerable numbers in vessels in the docks. A typical example (one of many) captured by a professional rat-catcher on board one of the Leith and Hamburg steamers while lying in Leith harbour in June 1890, was procured by Mr Eagle Clarke for the Edinburgh Museum, and recorded in the *Scottish Naturalist* (1891, p. 36), and I have seen another specimen, also taken on a Leith steamer, still more recently. Mr Thomas Hope, taxidermist, George Street, tells me that some nine or ten years ago, one, which had been captured in an Edinburgh skinnery, was brought to him for preservation. If his identification, which I have no reason to doubt, was correct, this is the last Edinburgh *Mus rattus* I have been able to trace.

The Black Rat was, of course, well known to Sibbald, Walker, and other early writers. Neill includes it in his Habbie's Howe and Tweeddale lists (1808 and 1815), and Stark ("Picture of Edinburgh," 1834) tells us that it "still inhabits the garrets of the high houses in the old city." Two years later Rhind dismisses it with the remark, "now rare" ("Excursions," p. 132); and in 1838 MacGillivray ("British Quadrupeds," p. 238) wrote thus—"In Edinburgh it appears to be completely extirpated, as I have not seen a specimen obtained there within these fifteen years."

In his list of Forfarshire animals (1813), Don says the Black Rat "is the only species I have seen in the town of Forfar, and it is not rare in all the inland parts of Angus-shire" ("Headrick's Agriculture of Forfar," App., p. 38).

The brown furred or tropical race, known as *Mus alexandrinus,* though abundant in the shipping in the Forth, apparently more so than the typical form, is not yet known to have obtained a footing on shore. The first record is that of an example received in Dec. 1888 by Mr Harvie-Brown from H.M.S. "Devastation," then stationed at Queensferry, and reported by Mr Eagle Clarke at a meeting of the Royal Physical Society on 19th March 1890; subsequently (August 1889) Mr Clarke had a cageful brought to him by a professional rat-catcher, who had just captured them on board one of the Leith and Aberdeen steamers (*Scot. Nat.,* 1891, p. 36). I have since examined several others, also from Leith steamers. In Bell's "British Quadrupeds" the occurrence of this race in Britain is not positively asserted, though Lord Clermont, in 1859, had written—"Is often found in numbers in vessels from Egypt when discharging their cargoes of corn in British ports, but does not appear to spread in those towns, being probably kept down by the common species" ("Quadrupeds and Reptiles of Europe," p. 100).

Mus musculus *L.* House Mouse.

The House Mouse is only too common throughout the length and breadth of the district, establishing itself in and about human dwellings and other buildings, no matter how

isolated they may stand. Having been for many years intimately connected with farming operations, I have often witnessed the havoc they commit in the stackyard, but their habits and economy are too well known to justify any remarks upon them here. Several specimens of a pale buff or cream-coloured variety were obtained for me in April 1890 by Mr R. S. Anderson of Peebles, from the farm of Lyne, where they were then in some abundance.

It is now impossible to trace the origin of this animal in the district. All that can be said is that its first appearance must have taken place many centuries ago.

MUS SYLVATICUS *L.* WOOD OR LONG-TAILED FIELD MOUSE.

This timid but destructive creature is very common throughout most parts of the district, ranging from sea-level to a considerable elevation, and inhabiting woods, fields, and natural pastures alike. Though thus widely distributed, there can be no doubt it occurs in greatest numbers in the plains and warmer parts of the valleys, and practically avoids the damp upland tracts in which the Field Vole seems to delight. In the immediate neighbourhood of Edinburgh, where it is very abundant, I have recently trapped numbers among the furze bushes on the Braid and Blackford hills, among rough grass by the Braid burn, in the woods at Dreghorn, and at the foot of the Pentlands near Swanston; and have otherwise captured or identified it near Balerno, near Currie, at the head of Bonaly glen in the Pentlands, and in the woods at Rosslyn, Glencorse, Penicuik, etc. Many specimens have also been obtained for me in the garden and grounds at Colinton House, and in the woods and cottage gardens in Dalmeny Park. In East Lothian, where it is also abundant, I have trapped it on Luffness Links near Aberlady, and in the woods at Gosford; while in Fife I caught one at Otterston last August, and have lately detected it in the woods at Broomhall near Dunfermline, and in the neighbourhood of St Andrews. In Peeblesshire I have observed it at Macbiehill and at Eshielshope; and Mr J. Thomson tells me it is common at Stobo.

I have thrice had examples handed to me which were captured in dwelling-houses during winter, and have often seen its nests turned up by the plough. Having trapped them commonly in January and February during frost and snow, I conclude it does not hibernate in the true sense of the word, but we know it lays up stores of food for winter consumption. Being strictly nocturnal, these pretty little animals, though so abundant, are—unlike the Voles—seldom seen abroad in the daytime. During the last four months I have kept several in a cage with a covered-in portion at one end. In this den they have formed a nest of cotton and other soft materials, in which they pass the day snugly curled up and apparently fast asleep. After dark they come out to feed, and remain very active throughout the night, even although the gas be burning brightly in the room. When feeding, the motion of the under jaw is so rapid as almost to amount to vibration. Some weeks ago one escaped from the cage, and has since lived at large in the room, hiding itself during the day in a fold of the window-curtain. When surprised on the floor at night it climbs the curtains with astonishing rapidity, runs along the picture-rods, and, with a knowing look, sits up in kangaroo-fashion cleaning its face with its paws.

Among those that have passed through my hands I have noticed considerable variation in size and also in colour, some being much darker than others, the result of more black on the tips of the hairs. Probably these differences of tint are connected with the seasonal changes of fur.

Mus sylvaticus is included in Neill's list (1808), and in Rhind's list (1836).

MUS MINUTUS *Pall.* HARVEST MOUSE.

My efforts to obtain specimens of this interesting little animal from the district have proved singularly unsuccessful, and I find myself practically unable to add to the few records already in existence. Not only must it be very local, but I do not think it can be anywhere numerous, and it would

seem to have been more easily procured in MacGillivray's day than now.

In Rhind's list of mammalia found in the immediate neighbourhood of Edinburgh ("Excursions," 1836, p. 132), "Mus messorius," the "Harvest Mouse," is entered with the remark, "not uncommon" against it; and MacGillivray states in his "British Quadrupeds" (1838, p. 257) that one was sent to him "from the neighbourhood of Edinburgh," and also that he once "found its nest in Fifeshire." In the "New Statistical Account" (Clackmannanshire, 1840, p. 9) it is included in a list of the animals of the parish of Alloa, and as pointed out by Mr Alston (Scottish Mammalia, p. 28), its size and weight correctly noted.

Mr Small, taxidermist, Edinburgh, assures me that about thirty years ago he received two, and within a week a third specimen for preservation. They were all from the same person, and Mr Small believes they were captured near Duns in Berwickshire. Curiously enough, I learn from Professor Duns that he once found a nest in the neighbourhood of the same town; this was prior to 1844. In August 1885 I found an unmistakable nest of this Mouse in a tuft of coarse grass growing under a hedge surrounding a corn-field behind Aberlady in East Lothian. It was about eighteen inches above the ground, and was supported entirely by the stems of the grass and a few of the twigs of the hedge.

Since this paper was read, Mr D. F. Mackenzie, factor, Mortonhall, near Edinburgh, has informed me that he last year observed a number of compact round nests among a heavy crop of oats on the home-farm there. They were placed one to two feet from the ground, and belonged to a small reddish mouse which he saw more than once sitting on the heads of the corn. Hoping they would reappear in the barley with which the field was this year cropped, a strict lookout for them has been kept, but to no purpose, nor have they been seen in any of the other fields on the farm. From Mr Mackenzie's minute description, I have no doubt the animals were a small colony of Harvest Mice, but it would have been more satisfactory had I been able to examine a specimen.

LEPUS TIMIDUS *L.* COMMON HARE.

The Common Hare is, and seems from time immemorial to have been, one of the best-known of our low-country animals. The volumes of the "Old Statistical Account" testify to its former abundance in the district, and no doubt the protection afforded by the game-laws, and the destruction of its natural enemies, tended to still further increase its numbers during the present century. A turn of the tide, however, has set in since the passing of the Ground Game Act in 1880, which gives the farmer the right to kill hares on the land he occupies. The result, which the proprietors are naturally enough deploring, has been a marked decrease in most localities, in some amounting almost to extinction. In the immediate neighbourhood of Edinburgh, fifteen years ago, I am certain I used to see twenty for every one observed at the present day. As a rule, it is now only where the grounds in the proprietor's own hands are of large extent that the Hare is to be seen in numbers. A close time, say from some date in February to a corresponding date in September, is urgently needed.

Though mainly an inhabitant of the plains, it occurs in the valleys of all our hill-ranges, extending in summer up the slopes of the hills themselves, even encroaching on the pastures of its congener, the Mountain Hare.

Coursing—the chasing of hares with greyhounds—is a favourite sport in the district. A pack of harriers also hunts the east of Fife, and there is at the present time a pack of beagles in Linlithgowshire.

Fleming tells us that in Scotland the skins were formerly "collected by itinerant dealers, and annually sold in the February market at Dumfries, sometimes to the amount of 30,000" ("British Animals," p. 21).

LEPUS VARIABILIS *Pall.* MOUNTAIN HARE.

North of the Forth the Mountain Hare is abundant and indigenous among the Grampians, where I have seen it on many occasions, especially on the hills near Callander. Colquhoun, from what he says in his "Lecture on the Feræ

Naturæ of the British Islands," would have us understand that in his young days it was very scarce on the Loch Lomond hills. In 1822 he "had shot over the whole rugged ground at the head of Loch Lomond without moving a single blue hare, barring the hermit on Ben Voirla's crags." It is included, however, in an excellent list of the animals of the parish of Luss, written nearly thirty years before the above date ("Old Statistical Account," xvii., p. 247). Farther east I observed one—still very white—in the third week of April 1891 on a high ridge of the Ochils above Tillicoultry, and learned from a shepherd that the species is fairly numerous on that range.

South of the Forth it is abundant on most of the higher parts of the uplands from Lanarkshire through Peeblesshire to Selkirkshire, and extends along the Pentlands well into Midlothian. I believe there are some now on the Moorfoots also, but I have not yet had any indications of its existence on the Lammermoors, though I have made a number of inquiries on the point. It is generally understood that we owe their presence on the southern uplands entirely to the action of a few of the hill proprietors, by whom they have been introduced at different times within the last fifty to sixty years. Alston dates its existence in the south of Scotland from about 1860, but this is much too recent, as the following extracts show. In Chambers's "History of Peeblesshire," published in 1864, the following interesting passage occurs at page 525:—"The Variable or Alpine Hare is now not unfrequent on the hills, but is known to have been introduced from the north by the late Mr Clason of Hallyards about seventeen or eighteen years ago. The first of the species in Peeblesshire were set free by Mr Clason on one of the highest hills in the parish of Manor. The species seems now to be fully established and naturalised over a very considerable district, extending many miles from the original spot." It would appear, however, to have been known in Manor a number of years before the date here assigned, as it is included in a list of the quadrupeds of the parish published in the "New Statistical Account" in 1834. An extract from one of Mr Alston's note-books, published in the *Proceedings*

of the Natural History Society of Glasgow, vol. v., p. 73, records "that a Mr Hunter over at Glenbuck [on the borders of Lanarkshire and Ayrshire] turned out a number" about 1861. Mr B. N. Peach tells me that they increased very rapidly in that district, and that when living at Muirkirk, about twenty-five years ago, he found them quite plentiful. A few were also turned down by Mr Cowan about twenty-four or twenty-five years ago on the Silverburn hills, the highest of the Pentlands. From these three, and probably other points of introduction, the species has now spread over the greater part of the southern hill-country, where I have myself frequently observed them at various times of the year. In Peeblesshire I have recently come across them on the hills above Glen Sax and at the head of Manor; while in Selkirkshire I met with a few on Ettrick Pen and the hills above Tushielaw in June 1889. On the Pentlands they are well known as far east as the Cairn hills on the one hand, and Scaldlaw on the other; and Mr Cowan's keeper tells me they are still spreading. There are now a few on the north Black-hill, and on the south side of the range he saw one on Capelaw during the winter of 1889-90; another came under my own observation recently on a spur of Carnethy. On 1st January 1889, I made an excursion to the tops of Craigengar and the West Cairn-hill for the express purpose of seeing these Hares in their white coats, and was rewarded by the sight of several. Mr P. Adair, who has shot many of them on the latter hill during the last nine or ten years, informs me he has there seen a hybrid between this and the Common Hare, and in January last I examined an undoubted example from near Cardrona in Peeblesshire.

LEPUS CUNICULUS *L.* RABBIT.

At the present time the Rabbit is perhaps the most ubiquitous of all our mammals, abounding alike on the islands of the Forth, and the dunes by the shores of the firths and estuaries; in the fields and woodlands of the plains; and among the rocks and pastures of the hills, where it lives at almost all elevations. From Sibbald's statement (quoted

below) we may infer that it was also common and widely distributed in the district in the seventeenth century, though probably much less so than now; but I am inclined to think that between that time and the early part of the present century there was little if any increase in its numbers, except perhaps in a few localities. A combination of circumstances, however, among which the destruction of its natural enemies has probably not been the least important, has since favoured its increase, and now it can only be kept within bounds by systematic trapping and snaring.

On 23rd May last I found a Rabbit's nest at the foot of Auchinoon hill, in the parish of Midcalder, in an exceptional position. It was placed in the centre of a tuft of coarse grass, in what might have been a hare's "form," without the semblance of a burrow. In it were five young ones—blind and naked—enveloped in a mass of warm fur.

From Boece's "Description of Scotland," we learn that in the early part of the sixteenth century the islands of the Forth were "verie full of conies" (Hollinshead's translation, 1805 edition, p. 13); and in Stuart's "Priory of the Isle of May," page xl, reference is made to a deed, by which in 1549 the prior of Pittenweem conveyed the island to Patrick Learmonth of Dairsy, in which deed the island is described as now waste, and spoiled by rabbits from which the principal revenue used to accrue, but of which the warrens were now completely destroyed and the place ruined by the English. Bones of the Rabbit found in a "kitchen midden" on Inchkeith (*Proceedings of the Society of Antiquaries of Scotland*, ix., 453), may point to it as an inhabitant of the islands of the Forth at a still earlier date, though they may merely have belonged to an animal that had made its burrow in the mound, and died there. In a charter granted on 10th November 1621 by James VI. in favour of the burgh of Peebles, we find "cunnings" and "cunningaries" specifically mentioned (Chambers's "Peeblesshire," p. 544). Sibbald, in his "Scotia Illustrata" (1684), says of the *Cuniculus*, "of these there is great plenty everywhere with us, especially on the coasts."[1] In the "Old Statistical

[1] "Horum magna ubique apud nos copia, in Littore præsertim."

Account of Scotland," the Rabbit is often mentione but chiefly as an inhabitant of maritime localities. I vol. xvii., p. 577, we are told that when Binning woo at Tyninghame, was planted in 1707, "the East Linl . . . . were a dead and barren sand, with scarcely an grass upon them, and of no use but as a rabbit-warren The extensive sand-dunes stretching along the coast behin the village of Gullane, in East Lothian, have long been noted warren. De Saussure, the Swiss naturalist, who visite these "grandes plaines de sable" in June 1807, in compan with Patrick Neill, tells us that "un tres-grand nombre d lapins sauvages habitent ces dunes" ("Voyage en Écosse, vol. i., p. 162). Again, we read in Stark's "Picture of Edir burgh" (1834, p. 297), that the city market was then plenti fully supplied with rabbits "brought chiefly from the extensiv warrens at Gulane *Links* or downs in East Lothian."

Several varieties, doubtless the descendants of domesti animals run wild, are to be met with. One of these is thu referred to by Neill in the *Scots Magazine* for 1816, p. 170:- "On the Isle of May, in the entrance of the Firth of Fort there exists a well-marked variety of the rabbit, distinguishe not only by the great length of the hair, but by its silk fineness." Mr Agnew, for many years lighthouse-keeper (the island, tells me this form was still there when he le five years ago. I have recently observed a yellowish varie in some numbers on Gullane hill, and others with black f near Cramond and on the Pentlands.

A hundred years ago the skin was the most valuable pa of the animal; "The skins may be valued at 6s. a dozen, an the body sells at the rate of 5d. per pair" ("Old Statistic Account," parish of Dowally, vol. xx., p. 472). Now t skins are worth about 2s. a dozen, and the bodies are sc at 2s. 6d. a pair. Within the last two years the price of t skins has fallen by about one-half, owing to the large in portation from Australia and New Zealand.

If, as seems highly probable, the Rabbit was original introduced into Scotland, it was most likely by the monl The monastery on the Isle of May was founded by David before the middle of the twelfth century.

Order UNGULATA.

CERVUS ELAPHUS *L.* RED DEER.

But for the protection of the deer-forest, it is very doubtful if I should have been able to mention the Red Deer as still an indigenous animal anywhere in the district. Semi-domesticated animals are kept in a few of the parks of the nobility, but we must pass beyond Dunblane before there is even a chance of seeing the Stag on his native heath. The only deer-forest having any connection with the district is Glenartney, the southern portion of which touches the valley of the Forth, on the water-shed behind Doune and Callander. It has been fenced in about twenty years, and at the present time is said to contain fully 1000 deer. Stragglers are occasionally to be seen outside the precincts of the forest, but, as a rule, they do not wander far from it. I have myself observed them on the hills to the east of Loch Lubnaig, and Colonel Duthie informs me that he saw six, marching in line, on the braes of Doune, on the 22nd of July 1889—they were on the Doune side of the wire fence, which marks the march between Lord Moray's moor and the Glenartney forest. In the "Old Statistical Account" of the parish of Doune (xx., p. 49), it is recorded that: "On the sides of Uaighmor, the stag bounds along the heath;" and in Graham's "Sketches of Perthshire" (ed. 1812), it is stated to have been then (as now) occasionally seen in the neighbourhood of the Trossachs. "In hard winters," he says, "when provender is scarce, the Red Deer of the northern forests sometimes wander in quest of food and shelter, as far as Glenfinglas and the heights of Craig-vad" (see also the "Old Statistical Account" of Callander, 1794, vol. xi., p. 598).

About ten years ago Red Deer were introduced to the park at Hopetoun, Linlithgowshire, where I have seen them on several occasions. The keeper tells me there are twenty-six in the park at present, but that four years ago there were fully double that number. During the winter of 1889-90 a hind, doubtless an escape from Hopetoun, made its appearance in Dalmeny park, where it remained some months, but had

ultimately to be shot owing to the damage it committed among the young trees. In the park at Dalkeith Palace, a single hind may now be seen feeding with the herd of Fallow Deer kept there.

In former times the Red Deer must have been abundant and generally distributed in the south of Scotland. Tradition tells us that during the Middle Ages the Scottish kings and nobles were wont to hunt deer in the immediate neighbourhood of Edinburgh, and doubtless such was the case, though there is little reliable historical evidence to point to. Such tales, for instance, as that of the royal hunt of Roslin, in which King Robert the Bruce is represented to have staked the forest and estate of Pentland against the head of Sir William St Clair, must be regarded as in the highest degree legendary (*vide* Wilson's "Annals of Penicuik," 1891, p. 165). The Red Deer, which was probably in most localities long survived by the Roe, must now have been extinct in the lowlands for many centuries. Even in the mountainous country around St Mary's Loch, it seems to have been practically extinct for at least two hundred years. Professor Walker, after informing us that, according to Bishop Leslie, numerous stags of great size were found in the Meggat district about the year 1578, adds that the last of that region, after wandering solitary among the mountains for about thirty years, and known to all the inhabitants, was killed on the neighbouring hills of Annandale in 1763 ("Mammalia Scotica," 1808). It must indeed have been rare if it existed at all in that district in the beginning of the eighteenth century, for in Dr Pennecuik's "History of Tweeddale," published in 1715, it is thus referred to,—"Upon the head of this water [Meggat] is to be seen, first, a house deservedly called Dead-for-cald; then Wintrop-burn; Meggit-knows; the Crammel, which seems to have been an old hunting-house of our kings, for I saw in the hall thereof a very large *Hart's-horn* upon the wall for a clock-pinn; the like whereof I observed in several other country men's houses in that desart and solitary place, where both *Hart* and *Hynd*, *Dae* and *Rae* have been so frequent and numerous of old, as witness the name of the hill, *Hartfield*" (ed. 1815, p. 248). Hartlaw, Hartside, and

Hindsidehill are Lammermoor place-names (Muirhead's "Birds of Berwickshire," Introd., p. xv).

Remains of the Red Deer have been unearthed in almost every part of the district, thus proving what history and tradition vaguely indicate, namely, that the animal once roamed over the entire area. The following list of localities is taken from Woodward and Sherborn's "Catalogue of British Fossil Vertebrata"—Edinburgh, Elphinstone, Cockenzie, Drem, Athelstaneford, Seacliffe, Coldingham, Westruther, Kimmerghame, Whitrig Bog, Selkirk, Maxton, Linton, Uphall, Dundas Castle, Stirling, etc. Only a few weeks ago I was shown several leg-bones, which had just been found on the Pentlands, a locality whence many examples of Red Deer remains have been procured—specimens from near Bavelaw, for instance, also came under my notice not long ago.

Cervus dama *L.* Fallow Deer.

Seeing the Fallow Deer is not an indigenous animal in the country, and exists only in a semi-domesticated state in parks specially enclosed for its reception, its right to a place in this paper may be questioned. With Bell's "British Quadrupeds" as a precedent, the usual practice, however, has been to include it in local faunal lists, and I see no reason to depart from that rule in the present instance. After all, it is practically as much entitled to a place in our fauna as the pheasant, and its claims to that distinction are certainly quite as good as those of the Canada goose or the mute swan.

Without attempting to give a list of the deer-parks in the district, I may mention the following, with which I am personally familiar, namely:—the Duke of Buccleuch's park at Dalkeith, and the Earl of Morton's at Dalmahoy, both in Midlothian; the Earl of Hopetoun's, at Hopetoun House, Linlithgowshire; and Mrs Hamilton-Ogilvy's, at Biel, in East Lothian.

The regulation strength of the Dalkeith herd is 300, and at the present time it contains rather over than under that number. Their presence adds another to the many charms of that fine park, and I know few more enjoyable sights than

to see them bounding through the tall brackens in the depths of the old oak-wood. Mr Chouler, the Duke's gamekeeper, tells me the bucks begin with great regularity to "bellow" on or about the 9th of October, and by the middle of the month they may be heard grunting in all directions. During still moonlight nights the park then resounds with their hoarse voices, the general effect being sufficiently wild, in my estimation, to afford genuine pleasure to the naturalist. The first fawns are almost invariably dropped on 16th June. The number of Fallow Deer in the Hopetoun park at present is only 140; fifteen years ago they numbered fully 250. In the Biel park there are between 200 and 300, and I understand the Dalmahoy park contains about the same number. These herds, which contain both spotted and uniformly dark animals, of course serve a useful as well as an ornamental purpose, and furnish their owners and the game-dealers with a constant supply of excellent venison.

In 1889 I observed Fallow Deer in Eshielshope, near Peebles, on the property of Sir John Hay, Bart. They were introduced, I am told, forty-two years ago, and at one time numbered nearly two hundred, but lately they have been killed down owing to their destroying young trees and adjoining farm crops, and now only about a dozen remain.

So far as I am aware, the date of the introduction of the Fallow Deer into the district is not known. We have positive knowledge of it, however, as far back as 1283, for which year the accounts of the king's chamberlain record, among other expenses connected with the royal park at Stirling, an allowance for mowing and carrying hay and litter for the use of the Fallow Deer in winter (Cosmo Innes's "Scotland in the Middle Ages," p. 125). From an observation made by Walker in his "Mammalia Scotica," which is supposed to have been written between 1764 and 1774, it appears that Fallow Deer have been kept in Hopetoun park for at least a couple of centuries. The white and the black varieties, he tells us, had existed there for sixty years without intermingling, until the mottled form was introduced, from which time all three forms brought forth young differing in colour from their own kind. He

also states that the dark variety was first introduced into Scotland by James VI. The Dalkeith deer-park is mentioned in the "Old Statistical Account" (vol. xii., p. 27).

CAPREOLUS CAPRÆA *Gray.* ROE DEER.

At the present time the Roe Deer is locally not uncommon in the district. In Midlothian it is practically confined to the upper section of the country drained by the two branches of the Esk, the individuals now and again seen in other parts of the county being mere wanderers. From 1865 to 1872 I was very familiar with it on the wooded banks of the North Esk above Penicuik, where as many as eight or nine might occasionally be seen together. A few were shot annually, so that their numbers scarcely varied from year to year, but there is reason to believe a heavy toll has occasionally been levied from them during recent years. About two years ago, I startled one in the old haunts, and the head of another, which had been killed in the woods near Glencorse in December last, was shown to me a few days ago. Wanderers may be seen almost every year crossing the Pentlands, and I have a record of one shot in Midcalder parish. On the South Esk it is well known in the country around Temple, and quite recently I had an excellent view of one in a large wood between that village and Gorebridge. It may also be seen from time to time in the adjacent parts of East Lothian (the woods at Humbie and Salton, for instance, are localities from which I have had it reported), but throughout the rest of that county it seems to be entirely absent, nor can I hear of it in the adjoining parts of Berwickshire, except as a rare straggler as far east, however, as the Pease dean woods (Letter from Dr Hardy). In Peeblesshire they have established themselves in most of the large fir plantations which now clothe the hill-sides on both banks of the Tweed, and a few are annually shot by the sportsmen of that district. In November 1888 I was delighted to see a party of six bounding through a thicket in the grounds at Portmore, near Eddleston, and a similar group may be seen in the woods at Dawyck. In Linlithgowshire, I am

told, it is occasionally seen, chiefly in the more inland parts; and in most of the woodlands of Stirling and south-west Perth it is more or less common. It inhabits the extensive woods at Tulliallan, where I have myself seen it, and its appearance in the plantations of some of the adjoining properties is not a very rare occurrence. In the west of Fife it is not uncommon in the neighbourhood of Saline, for instance; but in the east of the county it appears to be rare —a few, however, still exist in the woods at Falkland.

In olden times the Roe was, without doubt, much more abundant and generally distributed in the district than now, but the destruction of the forests and thickets, the growth of agriculture, and the loss of protection, gradually drove it from the southern section of Scotland, so that during the whole of the eighteenth century, and probably longer, it seems to have been entirely absent from our bounds, except in the mountainous country around Callander. In most localities the "Rae" probably long survived the Red Deer, but, apart from tradition and a few place-names, there is comparatively little evidence of its former abundance. I cannot recall any direct historical evidence for the area with which we are more immediately concerned, but as proving the existence of the animal in the south of Scotland during the reign of Alexander II. (1214-1249), I may refer to the oft-quoted agreement between the Avenels and the Monks of Melrose, by which the latter were expressly precluded from hunting Hart and Hind, Boar and Roe, in the forest of Eskdale (C. Innes's "Sketches of Early Scotch History," p. 103, and the Duke of Argyll's "Scotland as It Was and as It Is," 2nd ed., p. 52). Remains of the Roe seem to be less frequently brought to light than those of the Red Deer. The discovery by Dr Hardy of a portion of an antler in the vicinity of an ancient British camp at Oldcambus, in the extreme east of Berwickshire, is a fact of much interest (*Proc. Berw. Nat. Club*, ix., p. 242). As already mentioned (p. 148), the animal is alluded to by Dr Pennecuik (1715) as a former inhabitant of Tweeddale, and in Chambers's "History of Peeblesshire" (1864, p. 525), we read, "Of the animals which have become extinct in Peeblesshire, tradition pre-

serves the memory only of the Red Deer and the Roe. The latter seems to have survived after the extinction of the former. It is probably, however, at least two hundred years since the last really wild deer was killed in the county." The nearest parish in which I find it mentioned in the "Old Statistical Account" is Callander; "Roes," says the writer, "breed in our woods" (vol. xi., p. 598).[1]

Prior to the middle of the last century, comparatively few artificially-planted woods of any extent existed in the district. About that time, however, the planting of trees became very popular among the proprietors of the land, and in the course of the next twenty or thirty years thousands of acres in all parts of the country were utilised in this way. By the beginning of the present century many of these plantations were of sufficient growth to afford excellent shelter to such an animal as the Roe, which was now, so to speak, being invited to return to its former haunts. The return movement soon set in, and in the course of a few years the Roe had made its appearance in many localities from which it had long been absent.[2] In the "New Statistical Account" of the parish of Alloa (page 9), we read that "Roe-deer . . . . have been seen occasionally for more than thirty years in Tullibody woods," and the writer of the article on Tillicoultry, in the same volume (Clackmannanshire, p. 70), says of it, "occasionally seen in the neighbouring plantations." In the same publication it is included among the wild animals of Gargunnock and Fintry in Stirlingshire. "In Fife," writes Fleming (1828), "they have reappeared of late years, in consequence of the increase of plantations" ("British Animals," p. 26); and Professor Duns, in an article on the migration of mammals, contributed to "Science for All," mentions their subsequent periodical appearance in a plantation bordering on the banks of the Avon, in Linlithgowshire. From an incidental remark in Jackson's "Chivalry of Scotland in the Days of King Robert Bruce, including the Royal Hunt of Roslin," published in 1848, the date of its reappear-

[1] See also Graham's Sketches of Perthshire.

[2] A return movement was noted before the close of last century in the valley of the Tay ("Old Statistical Account," Little Dunkeld, vi., p. 361).

ance at Penicuik, on the south side of the Pentlands, may be fixed at from 1840 to 1845. "Deer in a wild state have," he says, "lately come to the woods of Sir George Clerk, Bart., about two miles from King Side Edge" (page 109).

Order CETACEA.

MEGAPTERA BOOPS (*Fab.*) = M. LONGIMANA (*Rudolphi*). HUMP-BACKED WHALE.

The true or "whale-bone" Whales mentioned in this paper can only be looked upon as casual visitors to our waters,—wanderers from their proper habitats in the North Atlantic and Arctic Oceans. They appear to be all more or less migratory, but the North Sea scarcely falls within the area of their periodical movements. Except in a very few instances, the occurrences cited in the following pages have taken place during the autumn and winter months, September being the most productive. Semi-fossil remains of large Whales have been found on several occasions (see Milne Home's "Estuary of the Forth," p. 25).

With us the Hump-backed Whale is a casual visitant of very rare occurrence. Of the three examples that have been recognised in Scottish waters, two may be mentioned here, namely, one which was cast ashore about two miles north of Berwick-upon-Tweed on 19th September 1829, and the famous "Tay Whale," which for five or six weeks in the end of 1883 disported itself frequently in the Firth of Tay opposite Dundee, to the astonishment of the good folks of that town.

The Berwick specimen, which was described and figured by Dr George Johnston in the *Transactions of the Natural History Society of Northumberland, Durham, and Newcastle-on-Tyne* (vol. i., p. 6), was between 35 and 36 feet in length, 24 feet in girth, and had pectoral fins 9 feet long. It was a female. In its stomach were six cormorants, and a seventh, on which it was presumed to have choked, was sticking in its throat. It was sold for £17, 2s. 6d., and yielded only about

eighteen gallons of very inferior oil. In Bell's reference to this specimen ("British Quadrupeds," 2nd ed., p. 394) there are two mistakes, namely, that it was cast ashore near Newcastle, and was 26 feet long.

Notices of the "Tay Whale" appeared in most of the newspapers at the time, the best account perhaps being that in the *Weekly Scotsman* of 5th January 1884. Subsequently, in 1888 and 1889, a very elaborate account of it by Professor Struthers was published in the *Journal of Anatomy and Physiology* (vols. xxii. and xxiii.). It was a male 40 feet in length, with pectoral fins 12 feet long, and was believed to have been attracted to the Tay by the abundance of young herring then in the firth. Some idea of its greath strength and endurance may be formed from the following facts:—After several fruitless attempts, the animal was at length successfully harpooned on 31st December (1883)—two, and finally three harpoons being shot into it. Large iron bolts, &c., were also fired into it, and hand-lances were driven three feet deep in its back. At first two six-oared rowing boats and a steam launch were made fast to it, and four or five hours afterwards a steam tug was added. With this heavy drag it swam wildly about the firth for a time, and then took out to sea, pulling all but the launch after it. For some time it pursued a northerly course till off Montrose, when it turned and proceeded towards the Bell Rock, then towards the mouth of the Firth of Forth, and finally turned north again when six or seven miles off the Carr Rock. One by one the harpoon lines had parted, and during the morning of 1st January, when some way south of the Bell Rock, the last line parted, and the Whale was again free, after being "fast" for nearly twenty-two hours to a dead weight of between twenty and thirty tons, which it was computed it had towed between forty and fifty miles. Of course it was wounded beyond the possibility of recovery. For the time being, however, it made its escape, and was not seen again for a week, when some fishermen observed the carcase floating off Bervie, and on 8th January towed it into Stonehaven harbour, where it was sold for £226 to Mr Woods, Dundee, who had it embalmed, and for the next seven months it was on exhibition in various

towns in Scotland and England. The skeleton was presented by Mr Woods to the Dundee Museum. Seeing this specimen, during its endeavours to effect its escape, is known to have approached within a few miles of the Carr Rock, the species may be given a place in the Forth fauna.

BALÆNOPTERA SIBBALDI (*Gray*). SIBBALD'S RORQUAL.

Sibbald's Rorqual, or the Blue Whale—the largest creature at present known to inhabit the globe—is another rare casual visitant to our shores, only three examples having been recorded during the present century. The large whale, 78 feet long, stranded at Abercorn, in the estuary of the Forth, in September 1692, and recorded by Sibbald ("Phalainologia nova," p. 33), in all probability belonged, as has been pointed out by Sir William Turner, to this species. Three undoubted examples, however, have since occurred in the Forth. The first is the huge animal, 80 feet in length, whose skeleton hangs in the Museum of Science and Art, Edinburgh. It was found floating dead at the mouth of the Firth in October 1831, and was towed ashore near North Berwick, and sold to Dr and Mr Knox, by whom it was dissected (see *Proc. Roy. Soc. Edin.*, 1833, vol. i., p. 14). Another, which Professor Turner has identified from the nasal bones, preserved by Dr M'Bain, was stranded on the Fife coast at Aberdour in July 1858 (*Report of British Association*, 1871, p. 144). And lastly, there comes the famous "Longniddry Whale," which was stranded a little to the west of Gosford Bay in East Lothian, on 3rd November 1869. During the fortnight it lay stretched on the beach thousands of people flocked to see it, and doubtless many of my readers, like myself, helped to swell the crowd. The carcase was purchased from the Board of Trade for £120 by an oil merchant in Kirkcaldy, who had it towed across the Firth and flensed on the beach close to that town. Professor Turner, who secured the skeleton for the Anatomical Museum of the Edinburgh University, has given a very full description of the animal in the *Transactions of the Royal Society of Edinburgh* (xxvi.,

pp. 197-251). It was a female, measuring 78 feet 9 inches in length, and contained a male fœtus 19 feet 6 inches long. Its girth was estimated at 45 feet, and its weight at 74 tons. It yielded 16 tons of oil.

BALÆNOPTERA MUSCULUS (*L.*). COMMON RORQUAL.

In the Common Rorqual or Razorback we have another rare straggler to the district, no specimen having been identified, so far as I know, since 1848.[1] The earlier writers did not distinguish between this and the last species, and in the volume on "Whales" in the *Naturalists' Library*, published in 1837, records clearly referable to each are brought together under the name of "Great Northern Rorqual." Of the examples there mentioned, the following are now generally referred to the present species, namely—One 46 feet long, stranded in the Firth of Forth a little to the west of Burntisland on 17th November 1690, and described by Sibbald ("Phalainologia," p. 29); another, "precisely of equal size," forced ashore very near to the same spot at Burntisland on 10th June 1761, and recorded by Neill (*Memoirs of Wernerian Society*, i., 212) from a MS. account of it by Dr Walker; and a male, 43 feet long, stranded near Alloa, in the upper part of the estuary of the Forth, on 23rd October 1808, and described by Neill (*op. cit.*, i., 201). The only example since recorded seems to be the female, 54 feet long, which was cast ashore near Kinkell, about three miles east of St Andrews, on 8th January 1848, and described by the late Mr R. Walker (*Scottish Naturalist*, vol. i., p. 107). In connection with this occurrence, it is worth noting that another whale, said to be of this species, went ashore near Aberdeen on 18th December 1847. The Razorback stranded "near Kingask, Fife, in 1848," of which Sir William Turner has some of the baleen (Alston, Scottish

[1] Van Beneden, in his "Histoire naturelle des Cétacés des mers d'Europe," 1889, speaks of an example in the Firth of Forth in April 1880, but the statement must, I fear, be one of the many inaccuracies which that work unfortunately contains, as no such occurrence is known to Sir William Turner, to whom I am indebted for valuable notes on this and allied species.

Mammalia, p. 17), and Walker's Kinkell animal, are understood to be one and the same.

In June 1752 a large whale was stranded near Eyemouth in Berwickshire, which was probably of this species (see Scoresby's "Arctic Regions," vol. i.); and Professor Turner informs me he has the skull of a specimen obtained at Bervie, Kincardineshire, in October 1889.

BALÆNOPTERA BOREALIS *Less.* RUDOLPHI'S RORQUAL.

In September 1872 a whale, which Sir William Turner has since shown to have been an example of Rudolphi's Rorqual, was captured at Snab, Kinneil, about a mile from Bo'ness, on the Firth of Forth, by some men who, seeing it floundering in shallow water, proceeded to the spot, and, having fastened a rope round its tail, hauled it nearer the shore, and then killed it. The *Scotsman* of 26th September contained a notice of the occurrence. The length of the animal from the tip of the beak to the end of the tail was about 37 feet, and its girth about 15 feet. The carcase, after being stripped of the blubber, was secured by Professor Turner, who, in order to thoroughly clean the bones and free them from the oil they contained, had them buried in the Botanic Garden in a mixture of earth and leaves, in which they were allowed to lie till the summer of 1881. The skeleton was then prepared for the Anatomical Museum of the University, where it is now preserved. Although captured in 1872, it was not till the skeleton had been carefully examined ten years later that Professor Turner became satisfied "that the animal was the Cetacean named by zoologists *Balænoptera borealis* or *laticeps*"—see his paper read to the Royal Society of Edinburgh, 20th February 1882, and printed in the *Journal of Anatomy and Physiology*, vol. xvi., p. 471, in which he minutely describes the specimen. This is the first properly authenticated example of the species taken on the British coasts, and is an addition to Alston's list of Scottish Mammalia.

BALÆNOPTERA ROSTRATA (*Fab.*). LESSER RORQUAL.

The Lesser Rorqual seems to enter the North Sea more frequently than its congeners, and as a consequence more examples of it have occurred in our waters. It can only be looked upon, however, as an occasional visitant.

On 15th May 1832, one 14 feet in length was captured in the salmon stake-nets near Largo (*Magazine of Natural History*, v., p. 570), and about two years later (February 1834) Dr Knox obtained a young one, 9 feet 11 inches in length, from "near the Queensferry" (*Proc. Roy. Soc. Edin.*, i., p. 63; and *Naturalists' Library*, "Whales," p. 143). The next I have a note of was found in the sea, apparently dead, near the Bell Rock, on 7th September 1857, and taken to Leith; it was 14 feet 5 inches long—see *Proceedings of the Royal Physical Society*, i., p. 441, where it is described by the late Dr M'Bain. According to Alston (Scottish Mammalia, p. 18) another was caught in the Firth of Forth in 1858. On 8th September 1870, an example about 18 feet long, and of which the skull and baleen are preserved in the Anatomical Museum of the Edinburgh University, was stranded near Burntisland;[1] and in September of the following year (1871) one was taken at Dunbar (skull, etc., in Anatomical Museum); while in 1872 another was caught in the herring-nets off Anstruther (Alston, Scottish Mammalia, p. 18). In the Anatomical Museum there is also the skull of a young male from Elie in 1879. Still more recently one (27 feet long) which I had the satisfaction of seeing in the flesh, was stranded at Granton Quarry on 24th January 1888 (*Scotsman*, 30th January), and in November following a small example was obtained near Alloa; both, I understand, were secured by Sir William Turner.

In the autumn of 1874, when on the North Sea, not far from the mouth of the Forth, I observed a Whale rise to the surface several times to "blow." It was probably an example of this species.

[1] On 29th July 1869, one 13 feet long was stranded near Arbroath (Scottish Naturalist, i., p. 111).

HYPEROÖDON ROSTRATUS (*Chemnitz*). BEAKED WHALE.

We now pass to the toothed Cetaceans, and the first species falling to be noticed is the Beaked or Bottle-nosed Whale, which appears to be an irregular but not very uncommon visitor to our shores in autumn. The *Proceedings of the Royal Physical Society* for 1885-86 (vol. ix., pp. 25-47) contains a valuable paper by Sir William Turner, F.R.S., on the occurrence of the species in the Scottish seas, in which he gives particulars of the following among other authenticated Scottish examples. It will be observed that, with one exception, they are females, each accompanied by a young calf.

1. An adult female, 28½ feet long, accompanied by a young female 9 feet long, captured at Alloa on 29th October 1845, and identified by the late Professor John Goodsir (see paper by Wm. Thompson in the *Annals and Magazine of Natural History* for 1846, vol. xvii., p. 153, where it is mentioned under Lacépède's name, *H. Butzkopf*). As pointed out by Professor Turner, an erroneous date (1839), which originated with the late Dr J. E. Gray ("Catalogue of Seals and Whales," 1866, p. 331), has been very generally assigned to this specimen. Dr Gray (*op. cit.*, p. 339) also referred to it as an example of his *Hyperoödon* (*Lagenocetus*) *latifrons*, under which name it appears in the works of Bell and Alston; but Professor Turner, who, I understand, has the skeleton of the animal in the Anatomical Museum, states that the skull does not possess the broad lofty crests of Gray's supposed species, which is now known to be merely the adult male of *H. rostratus*. Bell, I observe, further states that the calf which accompanied this specimen was a male, whereas Thompson says distinctly it was a female. Neither does the skeleton of the mother appear to be in the Museum of Science and Art, as stated by Bell and Alston, but in the Anatomical Museum of the University.

2. A female, 26 feet long and 15 feet in girth, captured at Grangemouth on 23rd September 1879: examined by Professor Turner.

3. An animal said to be 14½ feet long, found dead on the

shore at Blackness on 24th September 1879, and supposed to be the young of the last mentioned.

4. Two examples, probably mother and calf, stranded at South Queensferry in September 1883: sold to an oil merchant in Kirkcaldy.

5. A young male, 20 feet 6 inches long (22 feet following the curvature of the back), found on the beach between Tyninghame links and Peffer burn, near Dunbar, on 4th November 1885 (*Scotsman,* 5th November): procured by Professor Turner, and described in his paper above referred to.

In the *Scots Magazine* for 1808 (p. 37), the occurrence of an example of "*Delphinus bidens*" (Turton's name for the present species) was thus recorded by Patrick Neill:—"In the beginning of December [1807], during a strong breeze; a Bottlenose Whale (*Delphinus bidens*) twenty-one feet long, was stranded near Goulon Point, in East Lothian. The country people instantly stripped off the blubber, leaving the krang or carcase to those who should come after!"

MESOPLODON BIDENS (*Sowerby*). SOWERBY'S WHALE.

Of this comparatively scarce species only one example is known to have reached the shores of the south-east of Scotland. It was found in Dalgety Bay, near Aberdour, on the north side of the Firth of Forth, in October 1888, by one of the Earl of Moray's gamekeepers. The head, skeleton, and viscera were procured by Sir William Turner, who gave a description of the specimen at a meeting of the Royal Physical Society in December following (*Proceedings,* vol. x., p. 5), and subsequently described its stomach in the *Journal of Anatomy and Physiology* (vol. xxiii.). The animal was a male. Its extreme length in a straight line was 15 feet 1 inch, and its weight 15 cwts. The skeleton is preserved in the Anatomical Museum of the Edinburgh University.

As this Cetacean is probably a migratory species, visiting the shores of Northern Europe in the fall of the year, we may reasonably look forward to the occurrence of other examples in our waters at no very distant date.

DELPHINAPTERUS LEUCAS (*Pall.*). BELUGA OR WHITE WHALE.

The Beluga can only be regarded as a casual visitant of extreme rarity, its claim to a place in the fauna of the district resting on the occurrence of a single (male) specimen in the Firth of Forth so far back as 1815. It was killed early in June of that year in the upper part of the estuary, near Cambuskenneth, by salmon-fishers, who attacked it with fire-arms and spears. Hearing of the capture, Mr Robert Bald of Alloa promptly secured it, and had it forwarded to Professor Jameson of Edinburgh, and in December of the following year an account of it was communicated to the Wernerian Natural History Society by Dr Barclay and Mr Neill. Their paper, illustrated by two plates, on one of which is a sketch of the animal, was printed in the Society's *Memoirs* (vol. iii., pp. 371-395). For about three months it had been observed almost daily passing and repassing Alloa harbour, and it was often observed at Kincardine also. It generally passed up the estuary (in pursuit of salmon it was supposed) when the tide was flowing, and returned with the ebb. Measured in a straight line, its extreme length was 13 feet 4 inches. Its stuffed skin is still preserved in the Museum of Science and Art, Edinburgh.

The species being an inhabitant of high northern latitudes, and only a rare straggler to the European side of the North Atlantic, this specimen is likely still long to remain unique as a Forth example.

PHOCÆNA COMMUNIS *F. Cuv.* PORPOISE.

The Porpoise is by far the best-known Cetacean we have, occurring abundantly in the estuaries or adjoining waters throughout the year; it is, indeed, the only species which can be regarded as common and resident. In pursuit of its prey it ascends both the Tay and the Forth, practically as high as the tide flows, and it is not unfrequently captured in the salmon stake-nets by the shore and in herring-nets at sea. To those who take advantage of the summer sailings on the

Forth, the line of black fins appearing and disappearing in regular succession must be familiar. I have seldom gone an excursion of any extent, in any part of the estuary and firth from Alloa to the Isle of May, without observing a school of half-a-dozen or more rolling along in characteristic manner. In May 1887, while exploring the precipitous coast between St Abb's Head and Fast Castle in Berwickshire, I observed a couple of Porpoises fishing close in shore, and by remaining motionless for a few minutes had the pleasure of seeing them tumbling about in a pool within ten to twenty yards from the rock on which I stood.

The Porpoise was well known to Sibbald as an inhabitant of both firths, and he shows, from a charter granted by Malcolm IV. in favour of the monks of Dunfermline, that in those days the head of the animal was esteemed a great delicacy, and that it had also an economic value for the sake of the oil ("History of Fife and Kinross," 1803 ed., pp. 116 and 295).

ORCA GLADIATOR (*Lacép.*). KILLER OR GRAMPUS.

This species is probably a more frequent visitor to our waters than the few authentic records of its occurrence would lead us to suppose. Every now and then one hears of Grampuses being seen in the Firths, but owing to the vague way in which the name "Grampus" is used by the seafaring population of the district, these statements can scarcely be taken into account.

Sibbald, in his "Phalainologia nova" (p. 7), records the occurrence of several "Orcæ" in the Forth (at Culross and Blackness) in May 1691, and from his description of the animals there can be no doubt they belonged to the present species (Van Beneden so regards them in his "Histoire naturelle des Cétacés des mers d'Europe," p. 441).

In the *Scots Magazine* for October 1814 (p. 733), Patrick Neill gave an interesting account of a herd of "Grampuses" which appeared in the estuary of the Forth in the beginning of that month. On the 6th, fifteen of them were killed at the mouth of the Devon, about two miles above Alloa, and of

those which then escaped two were captured near Tullibody and two near Stirling. They were of various lengths, from 9 to 20 feet, and of both sexes. From the detailed measurements given of one of the largest, we learn that the length of the dorsal fin was 3 feet 3 inches, the length of the flippers 3 feet, and their breadth 2 feet 3 inches. From these facts, and the statements that "the back and sides were jet black, and shining; the belly pure white; and there was a large oblong white compartment behind each eye;" also that "there were two beautiful rows of teeth, 24 in each jaw, making 48 in all," there can be no doubt the animals belonged, as Neill inferred, to the present species, and not to the next, the Caaing Whale, as the writer of the "New Statistical Account" of Alloa (Clackmannanshire, 1840, p. 9) seems to have thought.

Fleming, in his "British Animals" (1828, p. 84), states that in the Firth of Tay, the Grampus "goes nearly as far up as the salt-water reaches, almost every tide at flood, during the months of July and August, in pursuit of salmon, of which it devours immense numbers." In all likelihood the animals on whose movements this statement was based, represented other species besides the present. The latest authenticated capture of the Killer in our waters of which I have a note is that recorded by the late Mr John Gibson in the *Proceedings of the Royal Physical Society* (vol. iv., p. 99). The record refers to a male having the following dimensions:—Total length along the curve of the back, 21 feet 10 inches; girth of body, 13 feet; height of dorsal fin, 3 feet 10 inches. It was captured about a mile west of Granton, on 18th March 1876, and "on being dragged ashore, while still alive, it gave forth shrill piercing cries, somewhat resembling in their sharpness a woman's voice."

A few years ago, I observed in the seaward portion of the Firth of Forth several Cetaceans, which, from the height and shape of their dorsal fins, I took to be of the present species.

GLOBICEPHALUS MELAS (*Traill*). PILOT WHALE OR CAAING WHALE.

The Pilot Whale may be regarded as an irregular spring and autumn visitant, though comparatively few authenticated instances of its occurrence have been recorded. There can be no doubt it is constantly confounded with the last species by the uninitiated, under the name of "Grampus."

The twenty-five Cetaceans mentioned by Sibbald as stranded at Cramond Island, in the Firth of Forth, in 1690 ("Phalainologia," p. 10), are referred by Professor Van Beneden to this species (see his recent "Histoire naturelle des Cétacés des mers d'Europe," p. 508). The writer of the "New Statistical Account" of the parish of Alloa considered that the "school" of small whales which occurred in the upper part of the estuary in October 1814 were referable to the present species, but, as I have already shown (p. 164), Neill's description of them, published in the *Scots Magazine* at the time, makes it perfectly clear that they belonged to the last species. From a statement in Don's list of Forfarshire animals ("Headrick's Agriculture of Angus," App., p. 39), it would appear that true "Ca'ing" Whales were stranded up the Firth of Tay prior to 1813.

The *Zoologist* for 1856 (p. 5095) contains a description by Dr J. Hardy of a male *G. melas*, measuring 20 feet in length and 11 feet in greatest girth, which came ashore among the rocks of Greenheugh, a short way to the west of St Helen's church, Oldcambus, Berwickshire, on 29th March of that year. At the same time another—much smaller—also came ashore a few miles farther west in the vicinity of Thorntonloch, in East Lothian. In April 1867 a herd, supposed to consist of about two hundred animals, was observed in the Firth of Forth for about a fortnight. On the 19th the Volunteer Artillery at Portobello practised at them without success. The following day they were attacked by fishing crews and others from Prestonpans, Newhaven, and other villages, and no fewer than twenty-three of them slain, amidst scenes of intense and savage excitement. The bulk of the slaughter took place in the bay on the east side of Granton harbour.

Three more were captured on the 22nd, and one or two others were cast dead on shore by the tide. These particulars are mainly taken from an account of the occurrence communicated by the late Mr E. R. Alston to the *Zoologist* (1867, p. 801). One of the animals (a female, 15 feet 2 inches in length), of which Mr Alston gives a description, was taken to Glasgow by a party of Newhaven fishermen and exhibited as a "Grampus," shoals of which, they said, were often seen about the Bass Rock, but it was very rarely they entered the Firth. Several of the animals captured on this occasion were secured for scientific purposes, with the result that our knowledge of the organisation of the species was greatly increased (see, for instance, Sir William Turner's paper in the *Journal of Anatomy and Physiology*, vol. ii., and Dr Murie's treatise in the *Transactions of the Zoological Society of London*, vol. viii.). The skeletons of two of the animals are preserved in Edinburgh—one in the Museum of Science and Art, the other in the Anatomical Museum of the University.

The Proceedings of the Berwickshire Naturalists' Club, vol. vii., p. 509, contains a record by Dr Hardy of an example 14 feet long, which came ashore in October 1875 at Burnmouth, near Berwick; and on 3rd August last (1891) two small whales, which—as reported in the *Scotsman*—were stranded at St Margaret's Hope, near North Queensferry, also belonged to this species, as I am informed by Mr John Simpson, assistant to Sir William Turner.

LAGENORHYNCHUS ALBIROSTRIS, *Gray*. WHITE-BEAKED DOLPHIN.

Up to the date of the publication of Alston's list of Scottish Mammalia, no authentic instance of the occurrence of the White-beaked Dolphin in the Scottish seas was known. Since then several have been taken on different parts of our coasts, both east and west. Although it has not, as yet, been identified in the waters of the Forth, the fact that it has been captured off the mouth of the Tay on the one hand, and off the Tweed on the other, renders it highly probable that a few occasionally visit the seaward portion of the Forth also,

and we may safely predict that its authentication for that area is only a matter of time.

On 7th September 1880 a young male was captured near the Bell Rock, and presented to the Kelvingrove Museum, Glasgow. This individual, which measured 5 feet 8 inches, was fully described by Mr J. M. Campbell at a meeting of the Glasgow Natural History Society on 30th November 1880, and in the *Scottish Naturalist* for January 1881 (p. 1).

In July 1881, an example was caught off Berwick, and in August 1883 another specimen—a young female—was also taken off Berwick and secured for the Kelso Museum, where its stuffed skin is preserved. The skulls of these two animals were handed over by the late Mr Andrew Brotherston to Sir William Turner, to whose "Notes" on the species, published in the *Proceedings of the Royal Physical Society* for 1888-89 (vol. x., p. 14), I would refer those who desire further information regarding the occurrence of this Cetacean in Scottish waters. The only examples I have myself seen in the flesh were an adult female and a young male, which were taken together off Stonehaven, Kincardineshire, in July 1888, and placed on view in the shop of Mr Anderson, fishmonger, Edinburgh. Both were purchased for the Anatomical Museum of the University by Professor Turner, who has given a minute description of them in his paper above referred to. The mother measured 8 feet 6 inches in length, and the calf 3 feet 11 inches.

It will be noted that this species has been observed on our coasts only during the months of July, August, and September.

DELPHINUS DELPHIS *L.* COMMON DOLPHIN.

The Dolphin, being more of a southern species than most of the other Cetaceans here mentioned, is probably only an occasional visitant to our shores.

The "Dolphin," as distinguished from the Porpoise, was specifically mentioned by Sibbald as occurring in the Firths of Forth and Tay in the seventeenth century, and their relative sizes were correctly indicated. His words are as follows:— "Of these [Delphinidæ] in both these firths there are two

sorts. The bigger beareth the name of Dolphin, and our fishers call them Meer-swines. The lesser is called Phocæna, a Porpess" ("History of Fife and Kinross," new ed., 1803, p. 115). In his "Phalainologia nova" (p. 6) he also mentions the "*Delphinus,*" as distinguished from the "*Orca*" and "*Phocæna,*" and gives an excellent figure of it, so that there is reason to believe some at least of his Dolphins were the true one. Attention may also be drawn to the fact that Don includes the species in his list of Forfarshire animals ("Headrick's Agriculture of Angus," App., p. 39).

In the Museum of Science and Art, Edinburgh, there is exhibited a stuffed specimen of the Dolphin, labelled "Firth of Forth," but I have not been able to learn more of its history. It is understood to have been preserved at least thirty to thirty-five years ago.

From these somewhat unsatisfactory records, we pass to the following recent and authentic occurrence of *Delphinus delphis* in the Firth of Forth. On February 1887, a boating party observed a school of six or eight small Cetaceans swimming about in pairs in a bay on the Dalmeny estate between South Queensferry and Hound's Point, and succeeded in shooting one, which proved to be a female of this species, measuring in a straight line 5 feet 5½ inches. It was procured by Sir William Turner for the museum of the University, and is fully described by him in the *Proceedings of the Royal Physical Society* (vol. ix., p. 346).

TURSIOPS TURSIO (*Fab.*). BOTTLE-NOSED DOLPHIN.

The following museum specimens furnish the only records I can find of the occurrence of this species within our bounds, namely:—Two specimens—a stuffed skin and a skeleton, perhaps taken from the same animal—in the Edinburgh Museum of Science and Art, labelled "Firth of Forth"; the skeleton of another, also from the Forth, which, according to Bell and Alston, formed part of the University collection formerly kept in the Surgeons' Hall; and three skeletons and a skull, all likewise from the Firth of Forth, in the zoological department of the British Museum.

Mr Eagle Clarke informs me that an entry in "The University Museum Register" shows that the specimen stuffed in the Museum of Science and Art was cast ashore at Portobello in the "year 1833-1834"; and it would appear, from Flower's List of Cetacea in the British Museum (p. 27), that the skeletons and skull in the national collection were purchased in 1866. The skull figured in the supplement to Gray's Catalogue (p. 73) is one of these specimens.

The Bottle-nosed Dolphin, though apparently only an irregular visitant to our waters, is probably less rare than has generally been supposed, and I think I may venture to predict that the capture and identification of fresh examples is only a question of time.

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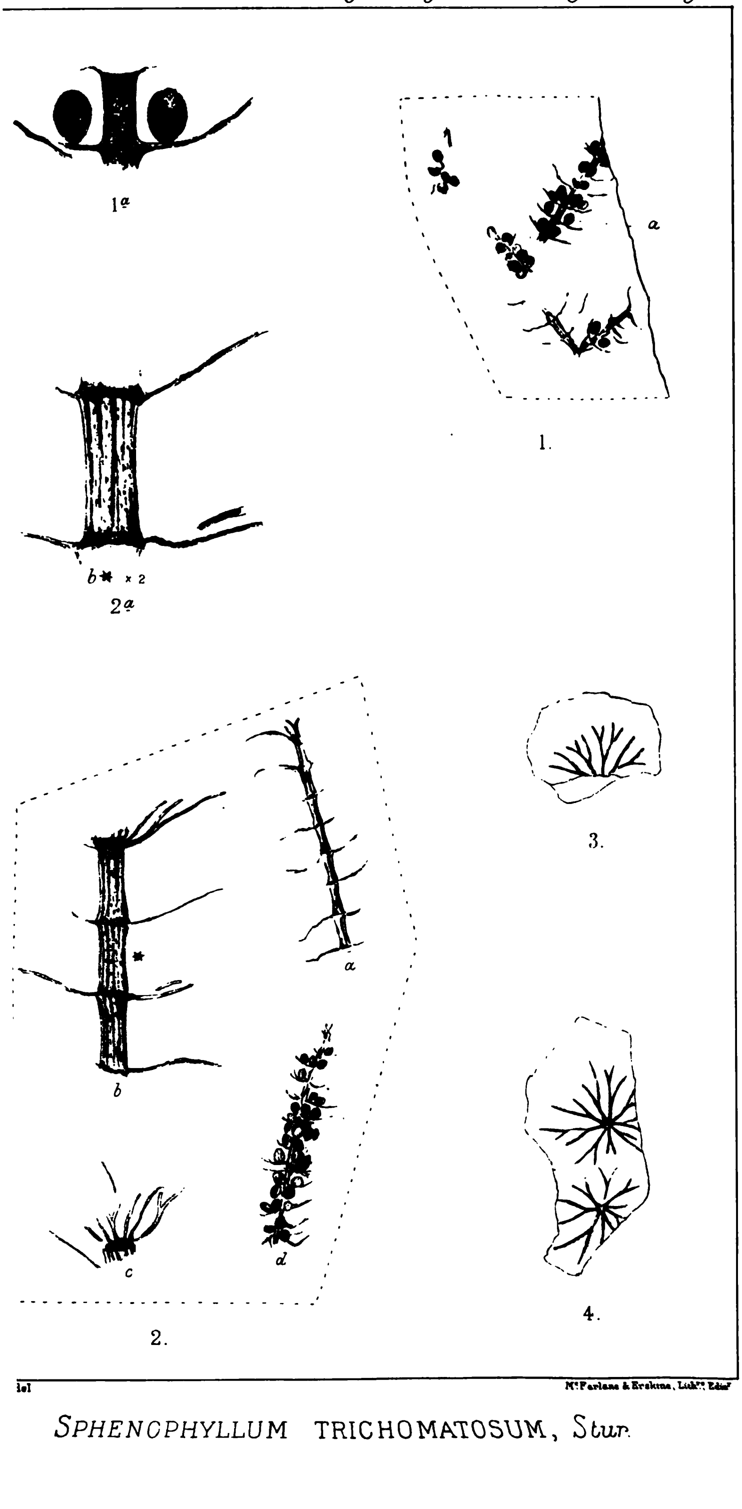

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SPHENOPHYLLUM TRICHOMATOSUM, *Stur.*

Fig. 1.

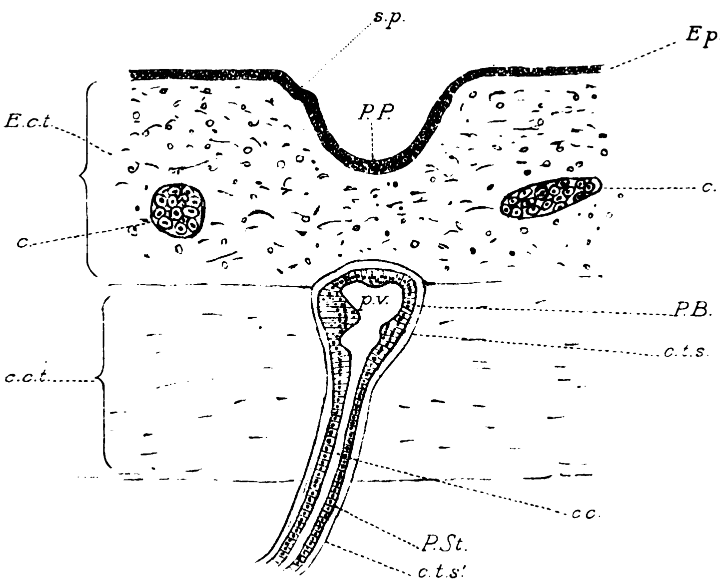
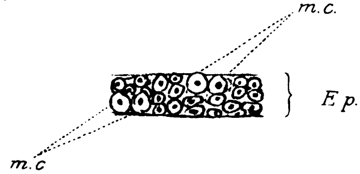


Fig. 2.



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PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION CXXI.

Wednesday, 18th November 1891.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

Dr R. H. TRAQUAIR, F.R.S., President, delivered the following opening address:—

I think that to most, if not to all, people who have any interest in natural history, the word "Museum" has associations which are decidedly of an agreeable character.

It is there that we go to get a closer and more complete view at preserved specimens of creatures which we may have only observed in the field,—to compare specimens collected by ourselves with those collected and named by others of greater experience,—or to make a practical acquaintance with natural objects which we may never be able to collect for ourselves, or even to see in their native habitats, and which we would otherwise know only from books.

The public to whom a natural history museum appeals is by no means a narrow one. It embraces, for instance, the expert engaged in working out a particular group of animals, and to whose work the study of large collections, especially those containing the original specimens upon which species have been founded, is absolutely essential. It embraces the

ordinary collector who does not pretend to be an expert, or who may be only a beginner, but who finds in the collections exhibited or preserved in public museums the most welcome assistance in naming and understanding the specimens of insects, shells, or other natural objects which he may employ his leisure time in collecting, or which friends may send him from abroad. It embraces the student getting up a subject, it may be for an examination, and who, though he may be possessed of ever so much industry and enthusiasm, will find his text-book dry and profitless reading indeed, if he has no opportunity of studying the actual objects therein described, and which it is impossible, even with the best figures, thoroughly to realise without seeing them. And it embraces also a numerous class of the general public, who may be neither experts, nor collectors, nor students, but who, having an interest in nature and natural objects to a greater or lesser extent, read popular books or articles on natural history, or books of travel in which such things are alluded to, and are laudibly curious to see the objects which otherwise would be to them little more than mere names. We read, for instance, of a strange parrot in New Zealand, which, since the colonisation of that country by Europeans, has taken to carnivorus habits, and digs into the sides of sheep—let us go to the museum and see a stuffed specimen, if there is one there. We read of gigantic birds, 12 or 14 feet high, taller than the tallest ostrich, which, though now extinct, once roamed about in that same distant land, and which, though never seen alive by the white man, were certainly hunted and eaten by the aborigines—perhaps we may see in the museum, if not a complete skeleton, at least some of their enormous bones. We read of the astounding phenomena of protective mimicry in animals; how mild-tempered honey-sucking moths may parade about dressed up as fierce wasps, thereby reversing the familiar saying of the wolf in sheep's clothing, or of butterflies gay and gaudy on the wing, but, when they alight on a bush, hardly to be distinguished from a withered leaf adhering to a twig—shall we not also visit the museum in search of these and other wonders of a like nature? I need not go any further in recounting things

which must be so familiar to all of you, but surely it is clear that to any one who approaches Nature from the scientific standpoint, and be it borne in mind that that need not exclude the æsthetic, a natural history museum, fairly well stocked and properly looked after, must be a place of great interest indeed.

Such being at least my own feelings on the subject, I must confess to having felt some amount of surprise when a little more than four years ago I saw "The Dulness of Museums" put down as the title of a paper in the *Nineteenth Century*, by the late Rev. J. G. Wood—the author being a man of considerable reputation as a writer of popular works on natural history. This article excited a good deal of attention at the time, and most of the comments made upon it, in the newspapers at least, were, so far as I remember, favourable to the views of Mr Wood. What these views were—wherein the dulness of museums lay in the eyes of Mr Wood, and by what means he proposed to enliven them—we shall presently see.

Meanwhile, it became very clear that, in the opinion of many of those who had a genuine interest in the subject, there was in most, if not in all of our existing museums, much room for improvement and reform. A paper by Professor Herdman of Liverpool, on the "Ideal Natural History Museum," appeared much about the same time as Mr Wood's article above referred to, and these were followed presently by an essay by Mr A. R. Wallace in the *Fortnightly Review*, in which he makes an account of a visit to the Museum of Comparative Zoology at Cambridge, Massachusetts, into a lesson for those who have to do with museums at home. In 1886 the British Association appointed a committee to inquire into the provincial museums of Great Britain and Ireland, and two reports from this committee were published in the *Transactions* of the Association for 1887 and 1888 respectively. In 1889 Professor W. H. Flower gave a very valuable presidential address on the subject of museums to the members of the British Association at the Newcastle meeting, and there has also been recently published a report by the same eminent authority on the condition of the

Oxford University Museum, embodying suggestions for its improvement and reform. On the Continent also, Professor Möbius, Director of the Zoological Museum in Berlin, has a few weeks ago published in the *Deutsche Rundschau*, a paper on the subject of natural history museums, so that you may here ask me, is not the subject already exhausted—is there anything more to say on it?

Well, the subject is an enormously wide one, and I venture to think that the ground has not been entirely covered in the literature to which I have referred. Nor do I consider the discussion to be entirely closed as regards many of the points raised by recent writers. If, then, I have chosen as a subject on which to address you this evening, one in which I may embody some of the results at which I have arrived in the course of my seventeen years experience as an official in a public museum, I do so without in the least way imagining that the last word will be said for a good long time to come.

The key to the whole position seems to me to rest in the answer to the question—What is a Natural History Museum, and what is its use? The original signification of the word, "home of the Muses," does not help us, as unfortunately there was no muse of natural history, and Urania, the only one of the nine who had scientific leanings, had astronomy as her speciality. To my mind the meaning of the whole matter is this—the study of natural history cannot be carried on without the use of specimens; a museum is simply the place where such specimens are kept, and the business of the curator and his assistants is to have them arranged in such a manner as will render them best available for the study and instruction of all classes and degrees of people who may be interested in them. Of course the duty of seeing that they are properly preserved, identified, and labelled goes without saying, but that is a part of the subject into which I need not at present enter.

It is not necessary, far from it, that all the contents of a public museum should be exposed in glass cases, though the "public" have often strange ideas on this subject. I once had opened a drawer of bird skins in one of our galleries, when a young man came up to me and indignantly

demanded to know why these were not exhibited to the public. I asked him if he had mastered the characters of the hundreds of stuffed birds exhibited in the glass cases along the gallery. He was taken aback, but not convinced. I then asked if there was any particular species, genus, or family of birds which he wished to study critically, but which was not represented in the exhibited collection, or insufficiently so for his purpose. Here he was silenced! but as far as ever from being convinced, and went away doubtless in the firm belief that we were doing a scandalous injustice to the British public in not hanging up to view every feather we had on the premises.

Others seem to imagine that one function of a museum is to contain a set of little monuments to the industry or zeal of individual collectors, and refuse to give or bequeath collections except under the stipulation that, regardless of all other considerations, they be for ever kept together and exhibited as the "Brown" or the "Jones" collection, as the case may be.

But the general voice of those whose opinions on the subject are worthy of consideration, is that the exhibited collections in a large museum ought to be more or less limited in extent, and in this I to a great extent agree. Whole classes of objects, such as dried insects and crustacea, lose their colours by exposure to light, and therefore only a selection of easily replaceable species should be so exposed. Fishes and reptiles in spirit not only become, in like manner, when exhibited, bleached and ruined, but as the spirit containing them becomes in most cases brown, their appearance is not attractive, while to the ichthyological expert a stuffed fish is in the majority of cases nearly useless. The ornithologist finds a collection of skins most useful for his purpose, but unstuffed skins of birds are hardly suitable for being looked at through glass. But far more than this, the exhibition of endless rows of closely allied species, as of stuffed birds, not only occupies much valuable space, but is bewildering rather than instructive to the general student. But of course the non-exhibited collections in a large museum should be freely available to *bona fide* students

and investigators who may have need to consult them, and every well-ordered museum should have rooms in which such students or specialists may be accommodated while engaged in such work.

But what of the exhibited collections? So far as the general subject is concerned, I should have typical examples of the various families arranged as Professor Flower very sensibly recommends, without overcrowding, and so that they can be well seen. Wherever any special interest attaches to a specimen, its label should be amplified into an explanatory note, and geographical distribution should be indicated by a free use of the little coloured maps now so extensively used for that purpose in various museums at home and abroad. If that is done, I hardly see the necessity for occupying space by large geographical groups or arrangements, upon which Mr A. Russell Wallace and others seem to put so much stress. And besides typical specimens illustrative of classification, all the animals, or other natural history objects which ordinary people are likely to read of in books of travel or popular natural history works, should be as well represented as possible. And I should also be pretty liberal in the exhibition of such objects as shells, even though my friend Professor Herdman may despise them as boards of books with their insides torn out, for the reason that many most excellent people collect shells, and are naturally desirous of having them named. For it must be borne in mind that there is a large class of students who can learn a very great deal through a glass case without ringing the curator's bell and demanding to see the specimens kept in reserve. And in a large museum there should be exhibited as complete as possible a collection of British animals, while in a smaller or country town museum there ought to be a similar collection of the animals of the district around. Though there is no use in showing to the public endless rows of foreign passerine birds, or hawks, or squirrels, on perches, yet every intelligent lover of nature should have the opportunity of seeing, without trouble, named specimens of the birds, beasts, fishes, and shells of the land of his birth or adoption, or of the district in which he lives, for these are things which he may come across in his walks, or of some of which he may

himself be an industrious amateur collector. The difficulty is with regard to insects and fishes in spirit, for rare species may be irretrievably damaged by light, and I should therefore most certainly also, in the case of British or local zoology, have another and still larger reserve collection to be kept in the dark, and only shown to specialists as occasion requires; and in these collections, specimens of insects, etc., which it would be difficult to replace should certainly be kept.

I should certainly have the birds and beasts in the exhibited collections well stuffed—no horrid distorted abortions of bad taxidermy; but I should have them mounted on plain polished wood stands, and in like manner all the mountings and fittings and labels, though plain, should be in good taste and pleasing to the eye. For though Art is no part of the functions of a natural history museum, it adds much to the comfort and pleasure of those who examine the specimens if everything around looks well.

But such an exhibited collection would have been pronounced to be "dull" by the late Mr Wood, and we may now inquire what he meant by that expression. He commences by saying, "I speak on behalf of the general public," and on reading his article we find that he does not mean even that part of the general public who have some sort of interest in natural history, but that unfortunately much larger part who have no manner of caring for the subject at all. It is on behalf of that class of people that he speaks of the eye becoming "painfully wearied by the monotony of long rows of beasts standing on flat boards, and of birds perched on short crutches, all looking intensely nowhere, and staring with extraordinary earnestness at nothing." Speaking also of the wonderful "Index Collection" which Professor Flower is now getting together in the entrance hall of the New Natural History Museum at Cromwell Road, and which contains so many beautiful, instructive, and admirably labelled osteological and other anatomical preparations, he says, "Now, what can Tom, Dick, and Harry know or care about the radius and ulna or the hyoid bones"? We who have to do with museums know this class of visitor very well—people who walk with perfect apathy through the

most interesting collections, who do not even trouble themselves to read any of the labels, and who go out, as Mr Wood says, "not one whit wiser than when they came in." Mr Wood also remarks that much of the same indifference is to be observed in the visitors to art galleries. "The general visitors stroll listlessly through the building, utterly failing to appreciate a single beauty of canvas or marble, and sometimes openly avowing that they wonder why people should make such a fuss about faded pictures and battered statues. To their eyes the grand contours of the Theseus Torso and the divine grace of the Milo Venus are invisible." He even owns that to himself "a collection of blue china is dulness itself."

How Mr Wood proposes to deal with this dense ignorance and apathy as regards painting and sculpture he does not say; but as regards natural history he proposes that, in addition to the museum for the various sorts of people whom I have indicated at the commencement of these remarks, there should be a special museum for Tom, Dick, and Harry, "which should amuse them, should be of such a nature as to compel them to take an interest in the subject, and perchance to transform them into the Thomas H. Huxleys, Richard Owens, and P. Henry Gosses of the next generation." This museum should consist, "not of isolated animals, but of groups, some large and some small, but all representing actual episodes in the life-history of the animals exhibited." In fact, this museum is to consist of groups of animals "pictorially mounted," amid artificial representations of scenery.

Mr Wood owns that his scheme is Utopian or ideal, and certainly there does not seem much immediate prospect of a separate museum being constructed on such a principle even in wealthy London. Yet the notion that the exhibited specimens in a public museum should be pictorially mounted, and not plainly and simply set up to display their zoological characters, is one which has a very considerable hold on the minds of a great number of people, and in some museums may be seen attempts to realise it. The idea seems to be, that as the acquisition of knowledge is distasteful to a great many people, something must be done to "gild the pill," and

to coax them into taking an interest in studies for which otherwise they would not have the smallest liking.

But there are, in my mind, very weighty objections to the plan, which I shall now briefly notice.

In the first place, if, as Mr Wood avows, the object be to catch Tom, Dick, and Harry, and by "amusing" them to teach them to be scientists in spite of themselves, I have very grave doubts as to its success. For these pictorial exhibitions appeal to a quite different faculty of the human mind than the desire for knowledge,—to the dramatic rather than to the scientific part of human nature; and the most of our people of that class would look at Mr Wood's groups with the very same eye with which they view a wonderfully realistic scene in a theatre—a landscape, for instance, with a real waterfall, or a marvellously imitated snowstorm—or with feelings akin to those with which they hear a successful mimic or ventriloquist, *only it would not be half so entertaining.* If you wish to *amuse* people, you should subsidise a theatre at once! Still more do I doubt the probability of evolving the future Huxleys, Owens, and Gosses out of such material and by such means. I do not know enough of the early life of these eminent men to be able to say how their scientific faculties were first roused into play, but so far as my knowledge and experience of such things go, a taste for natural history usually makes its appearance at a very early age, and is awakened by the fancy being caught by the natural objects which occur among our own immediate surroundings.

Mr Wood speaks of the sublimity of ignorance to be met with in the general public on whose behalf he writes, and gives a telling instance of an "Oxford tutor, since deservedly promoted to very high rank in the church," who was utterly astonished on learning that flowers had any connection with fruit! Yes, it is true that in this scientific age you will find among the most refined and educated classes abundance of people who, so far as the most elementary science is concerned, might as well be living in the third century. But for this the *only remedy* is the teaching of the elements of science in schools. There could have been no science master in the school in which Mr Wood's Oxford tutor received his early training.

2. These groups, unless absolutely well done and absolutely realistic, are of no scientific value; and to secure those conditions requires an enormous expenditure of money, as well as an enormous amount of space. It is all very well to refer to the great beauty and attractiveness of the, in many respects, charming set of cases illustrating the nesting habits of British birds in the Natural History Museum at Cromwell Road, South Kensington. These are the only really good things of the kind I ever saw, and, as they are as nearly as possible realistic representations of certain facts, they may be accepted as *bona fide* scientific specimens. But they have already cost a very great deal of money,—far beyond the resources of any other museum in the country, unless other things, more important from a scientific point of view, are starved or sacrificed; while inferior things, such as the groups we often see in the bird-stuffers' shops, with brown paper rocks, powdered glass for snow, and animals drinking at looking glasses for water, are simply ridiculous.

Again, to set up all the animals which it is desirable to exhibit in a public museum in a thoroughly realistic way would, even if it were possible to do so, require an amount of space far beyond the resources of an ordinary museum. And to show you what may be the result when space is small and absolute realism not sought for, let me refer to what I have seen in a public museum in a flourishing manufacturing town, the curator of which is a man of real ability. This was the condition of matters which I found when I visited that museum two years ago. To be scientific, the birds were classified according to zoological affinities; and to be attractive to Tom, Dick, and Harry, they were pictorially mounted on trees, with accompaniment of grass, leaves, etc. Now, who ever saw a flock of birds all belonging to one natural group, and at the same time natives of different countries and regions, all perched close together at the same time and on the same tree? But the treatment of the stuffed fishes was still more remarkable. You all know that by no amount of taxidermic ingenuity can you make a stuffed fish look as if it were fresh or alive, but here they were *swimming*

about in the air in a case or cases, with stones, sand, and dried starfishes at the bottom; while to give a conventional idea of water (a very conventional one indeed!), a brush with bluish-green varnish had in some places been drawn horizontally across the glass of the front of the case. Did the artist, who used his brush in so bold a way, ever see any such bluish-green horizontal lines across the glass of an actual tank filled with water in an aquarium? I do think that, in this case, it would have been much better if the birds and fishes had been plainly set up on stands, without any attempt to amuse the public by "pictorialism."

But where is this to stop? At the vertebrates? No, not in the opinion of some; for I have recently read a letter, published in a southern paper, from a gentleman who advocates the principle that, in a local museum, the entire local fauna should be set up pictorially in groups representing the life-history of the species, and in this letter the words occur: "Every animal species native to the district which it is possible so to display must be treated in a similar manner, even down to the beetles and worms." Well, I must say that if I were called upon to set up "pictorially" all the beetles of Midlothian, and all the worms of the Firth of Forth, I should be inclined to give it up as a bad job, as well as to consider the project an utterly vain and useless one besides.

And if this "pictorial" method is desirable for recent organisms, in order to make the general public take an interest in them, why not also for fossil ones? What can be more utterly dull to our friends Tom, Dick, and Harry, than rows of fossils mounted on tablets with terrible names attached to them, like *Dikelocephalus* or *Goniasteroidocrinus?* Let palæontology, then, be represented by a scenic model of the interior of a stone quarry, where the fossils shall be lying about on the ground, or some of them seen half sticking out of the rock; and perhaps, to add further interest to the scene, the effigy of a savant should be represented with his hammer breaking open a huge block of stone, from the interior of which the welcome features of the Missing Link burst upon his astonished gaze. This ought to take!

I have said that the late Mr Wood did not propose any remedy for the apathy of the public in the case of art museums. Would those who support his views have the Theseus Torso and the Milo Venus "pictorially mounted," in order that their merits might be appreciated by those who have no soul for art any more than for science?

It may, indeed, be well to brighten up a museum hall with a few really well-executed groups illustrative of important scientific facts, when space and funds allow of it; but to adopt the so-called pictorial method systematically, for the exhibited collections of a museum, seems to me to be absolutely at variance with the essential scope and function of such an institution.

If we now turn to Professor Herdman's paper, we find an absolutely different view of the matter presented to us. Instead of amusing the general public, and thus coaxing them, if possible, to take a little interest in natural history, he seems to aim at all at once converting them into deeply philosophical comparative anatomists and evolutionists. The principal part of Professor Herdman's museum is to consist of a large "Type Collection," placed in the ground floor of a hall sufficiently extensive for the purpose, the cases being arranged after the manner of a genealogical tree, so as to show the (hypothetical) lines of descent of the various groups of animals. There are to be abundant dissections as well as anatomical and embryological models, nay, indeed, there are to be models of things which nobody ever saw, such as the "*Protovertebrata*" and the "*Protoganoidei*," but which are simply *presumed* to have existed, in accordance with prevailing views of descent. Though he would supplement this arrangement by local and general collections, and, if space and money allowed, even by pictorial groups illustrative of geographical distribution, the main feature of his museum would be the genealogical tree designed to instil the details of comparative anatomy and the Descent Theory not only into the minds of the special student but of people in general. Well, I am afraid that my enthusiastic and able friend has got into a Utopia still further away from realisation than even that of Mr Wood.

Tom, Dick, and Harry might be amused (for a little) by the pictorial groups, but I am afraid they would find the genealogical tree even duller than the ordinary zoological collections with the birds on crutches and the beasts on flat boards. The study of comparative anatomy and of scientific zoology requires much time and much mental exertion, and to go deeply into it cannot be expected of any one but the special student, certainly not of those who have to occupy the best part of their brain power in the task of making their daily bread.

I am as thorough an evolutionist as Professor Herdman, and yet I cannot see that the main object of a public natural history museum is to teach ordinary people evolution against their will. And I also think that ordinary people may be very reasonably and profitably interested in zoology without being deep comparative anatomists. But as regards the special student, that is quite another thing, and for him should be provided a special type collection, as we shall see further on.

The next question which I shall bring before you is, how should the subject, usually known as "palæontology," be treated in a natural history museum? In most peoples' minds, the study of fossils is a part of "geology," though it ought to be plain to the meanest intellect that whatever be the bearings of palæontology on geology, the study of the fossils themselves is simply a part of zoology or botany, as the case may be. Yet so perverse is the human intellect, that, if a man works at a particular group of fossil animals, be it from a purely zoological standpoint, he will probably, to his surprise, soon find himself credited with a profound knowledge of "regional metamorphism"—"striated boulders"—"river terraces," and many other things which may not be at all in his line, —at least not specially so! And as he becomes erroneously credited as a "geologist," he will probably also become discredited as a zoologist, for his "biological" brethren will have none of him, or his fossils either! Yet *does an animal cease to be an animal because it is preserved in stone instead of in spirits?* Is a skeleton any the less a skeleton because it has been excavated from the rock, instead of prepared in

a macerating trough? Cuvier, and Louis Agassiz, and Huxley, and Owen did not and do not think so; but it seems to me that almost all present day working biologists look upon the extinct creatures, whose remains geology has revealed to us, as having nothing to do with the present life of the globe at all. One would have thought that the popularity of the doctrine of evolution would have invested the study of ancient life with a special interest in the eyes of our younger biologists,—but it is not so. They cut their embryos into thousands of sections, which they dye red and blue and yellow, and from what they see there, they construct genealogical trees showing how everything has been derived up from the very origin of protoplasm; but they seldom ask if the mode of branching of their tree is corroborated or the reverse by what we actually know of the past history of life on the globe. Or if it does strike them that a corroboration from palæontology would add interest to their views,—instead of finding out what are the most recently ascertained facts on the subject, and acquiring some practical knowledge of them as well, they will probably go to some mere text-book, and copy from it some antiquated figure, which they may not even understand, and from it find startling confirmation of their theory—for example, that vertebrates are descended from *Arachnida.* Do not suppose, for a moment, that I am so ignorant or insane as to speak slightingly of embryological research—all that I mean is, that it does not constitute *the whole* of biological science!

In his British Association address, Professor Flower remarks that—"For the perpetuation of the unfortunate separation of palæontology from biology . . . the faulty organisation of our museums is in a great measure responsible. The more their rearrangement can be made to overstep and break down the abrupt line of demarcation which is still almost universally drawn between beings which live now, and those which have lived in past times, so deeply rooted in the popular mind, and so hard to eradicate even from that of the scientific student, the better it will be for the progress of sound biological knowledge."

Here Professor Flower evidently alludes to the arrangement of the fossils in our museums in a department distinct from that which contains the specimens of existing organisms. There is doubtless something in that, at least, so far as the popular mind is concerned, but, as regards the "scientific student," I can scarcely withstand the temptation to throw a little of the blame on the narrowing tendency of the present fashionable type-system of teaching zoology, and the extensive concentration of the mind of the student on the subject of embryology.

Two years before Professor Flower delivered his address at Newcastle, there had been a discussion in the biological section of the British Association at Manchester upon the very subject of how our museums might be reformed in this direction. So far as that discussion is concerned, I do not think it ended in very much, but the plan, which I then recommended, I am now endeavouring to carry out in the rearrangement of the Natural History Department of the Edinburgh Museum at present in progress.

In the first place, recent and fossil organisms must be brought together, for the same life which animated the world in earliest geological times has been inherited by us at the present day.

In the second, recent and fossil species of one genus must not be mixed in one case, because the collection would thereby be ruined for the geologist, while the zoologist would probably give you no thanks.

A compromise must therefore be effected, and this is my plan. We divide the animal kingdom into classes in the usual acceptation of the term, such as Pisces, Amphibia, Reptilia, and so on, while we divide geological time into the great epochs as recognised by the majority of geologists at the present day. Then, under each great epoch of the world's history in succession, from the Cambrian, it may be, up to and including the recent period, we arrange zoologically the representatives of one of the classes of the animal kingdom, and when we have thus brought that class up to the present day, we repeat the process with the next which

it may be most convenient to take. For this plan I claim the following advantages:—

1. That it brings recent and fossil organisms sufficiently close together to show that they all form parts of one great system, and to emphasise the fact that palæontology is not a distinct science from zoology, while it does not confuse the minds of those who may only wish to study the details of the living forms.

2. It lays before the student, as it were, a series of tableaux showing the phases, so far as the geological record has revealed them to us, through which each great class of the animal kingdom has passed from ancient to modern times.

3. It enables the student who consults the collection from a geological standpoint, to see at a glance the leading orders, families, and genera of each great class of animals in each great geological period. But for the especial benefit of the geologist, this arrangement should be supplemented by a purely stratigraphical series of leading or characteristic fossils, the proper place of which is along with rock-forming minerals, rock-specimens, geological models, etc., in a purely and truly Geological collection.

A few words now as to educational or type collections.

In every large museum in a town which is a centre of education, there should be an educational or type collection, whose function is to aid students of zoology in acquiring the rudiments of their subject; and it should be arranged, not merely for the benefit of those who are cramming for examinations, but of those who may be studying the subject from the mere love of it. In many of its essential features that collection should be like that proposed by Professor Herdman, though not so large, nor need it be arranged in the form of a tree, for that might be very inconvenient as regards available space; and besides that, as I once heard remarked, Professor Herdman's cases would have to be put on castors, so that they might be shifted occasionally to suit the ever-shifting opinions of evolutionists as to the mode of branching of the said tree itself.

This collection should contain, in the first place, a set of well-prepared and properly labelled specimens illustrative of

the technical terms used in zoological descriptions throughout the whole range of the animal kingdom, terms which are often very difficult from books alone to learn rightly to understand and apply. Here also may be placed illustrations of general phenomena, such as mimicry, adaptation to surroundings, etc., as in the telling examples already placed in the Index Collection at the British Museum.

Then, to illustrate the leading principles of classification, it should also contain a limited but carefully selected series of specimens of animals from all the great divisions, down at least as far as the groups conventionally termed orders; while there should be intermixed with them a sufficient number of skeletons, dissections, and anatomical and embryological models, to show in what manner modern ideas of classification are founded upon structure and development. Throughout the collection, things which are microscopic should also be represented by enlarged models or drawings.

Here also palæontology should not be neglected; but extinct orders, such as Trilobita, Eurypterina, Ichthyosauria, Plesiosauria should be represented, in their proper places in the zoological system along with the recent ones, by good, clear specimens, if such are procurable, or by good casts, if originals cannot be obtained. The labels attached to the specimens in the type collection should be abundantly descriptive and explanatory—not exactly taking the place of a text-book, however, for though zoology cannot be learned without specimens, neither can books be dispensed with. But, indeed, a well-written descriptive catalogue of such a collection, when completed, would form a text-book of very considerable value to all classes of students.

Then, though I cannot see the necessity for arranging the cases in the form of a genealogical tree, I would have no objection to indicate the latest views on the phylogeny of the various groups by means of diagrams, always, however, taking care to make the student bear in mind that such views, however *probable* they may be in many cases, are yet after all in most only hypothetical.

You will say that this is just the sort of collection which, under the name of Index Collection, is now being put up in

such splendid style in the hall of the New Natural History Museum at South Kensington. Very like it indeed, but not exactly the same; for, according to my ideas, classification ought to be a stronger feature in the type collection than it is at Cromwell Road, and should, I think, go as far at least as the orders. I hope you will not consider me egotistic in referring once more to what is being at present done in the Edinburgh Museum under my superintendence. For the type collection, the space we have to work upon is the upper gallery of a rectangular hall lighted from the roof, and this provides for one very necessary thing in the educational collection, namely, plenty of light by which to see the specimens. Round the walls are placed upright cases of moderate height and depth, in which are being arranged representatives of the various orders, with anatomical preparations and embryological models, illustrative of the reason why animals are so classified. The parapet of the gallery is occupied by desk-cases, destined for the preparations to illustrate technical terms, and these will be arranged as nearly as possible in positions opposite the wall-cases containing the classes and orders of animals to which they specially refer. For example, in the case of birds, the desk-cases contain illustrations of the topography of a bird's body, of the structure of feathers, of the various kinds of feathers, of the various types of palatal structure, of the different forms of sterna, bills, feet, tails, etc., all labelled with the technical terms applied to each modification in ornithological works. On the opposite wall-case a few selected examples of each order of birds are placed, along with skulls, showing the particular type of palatal structure characteristic of that order, and to which other preparations will be added as time and opportunity allow. But the getting together of such a collection in any degree of completeness is naturally an extremely difficult one, and it may yet be several years before all the great classes of animals are illustrated in the manner they should be.

Time will not permit me to enter into the subject of the Mineralogical and Geological collections which should form integral parts of a large Natural History museum or

department, nor is this necessary, as there is really not much room for controversy with reference to their treatment. Only to two things need I refer. The first is, that fossils exhibited in a "geological" collection are there for the purpose of being looked at from their geological, rather than their biological, aspect, and should consequently be arranged in purely stratigraphical order. The second is, that I once heard it proposed that the section-models, used for illustrating local geology, should be constructed and manufactured out of the actual rocks occurring in the district to be illustrated. I mention this proposal without comment.

In bringing these remarks to a conclusion, I wish you expressly to understand that they refer to large public museums, such as we may expect to find in towns of 250,000 inhabitants and upwards, and which are reasonably endowed with means for their maintenance. Small museums require of course special treatment, but one great principle is at the bottom of the whole idea of a museum.

It is this,—A museum is a place where people who wish to study may find the material necessary for such study. But I have no faith in the idea of its being a place where people, who have no natural inclination for the studies concerned, may, by theatrical display, be induced to cultivate an inclination which they would not otherwise possess.

I have now, gentlemen, performed the last duty in connection with the occupation of this chair, to which three years ago you did me the great honour of electing me for the third time, and in vacating it this evening, I again thank you most heartily for that honour, and for the friendship and good-fellowship which I have experienced from the members of the Society during the long period for which I have been connected with it.

XI. *The Occurrence of Risso's Dolphin* (Grampus griseus) *in the Shetland Seas.* By Professor Sir WILLIAM TURNER, F.R.S.

(Read 16th December 1891.)

Risso's Dolphin (*Grampus griseus,* G. Cuvier), which, from the peculiar striped character of the skin, presents so remarkable an appearance, has from time to time been captured in European waters. In the Mediterranean and on the Atlantic seaboard of France, several specimens have been obtained, and solitary individuals have been caught on the coasts of Portugal, Sweden, and Holstein.

Specimens have also been occasionally taken in the English Channel. In the spring of 1843 one was killed at Puckaster, in the Isle of Wight.[1] A female was caught in February 1870 in a mackerel-net near the Eddystone Lighthouse;[2] another female was sold in Billingsgate Market in March in the same year, and was probably captured in the Channel;[3] an immature male was taken alive in the English Channel in July 1875 at Sidlesham, near Chichester, and was kept alive for twenty-four hours in the Brighton Aquarium.[4] In February 1886 a female was caught in a mackerel-net about twenty miles south of the Eddystone, and was exhibited in Plymouth.[5]

So far as I can ascertain, no specimen has yet been described as caught in Scottish waters. The following account, therefore, will be of interest, as giving both a Scottish habitat for this dolphin and the most northerly point (lat. 61°) at which this animal has been seen. In

[1] Recorded by Rev. C. A. Bury, Zoologist, vol. iii., p. 813, 1845. The sex is not stated. The skull is in the British Museum.

[2] Described and figured by Professor Flower, C.B., Trans. Zool. Soc., 1871. The skeleton is in the British Museum.

[3] Described and figured by Dr James Murie, Jour. Anat. and Phys., Nov. 1870, vol. v.; also by Professor Flower (*supra*). The stuffed skin and skeleton are in the British Museum.

[4] H. Lee in Proc. Zool. Soc., 1877, p. 808.

[5] Described by Mr F. H. Balkwill in Trans. Plymouth Institute, parts ii. and iii., 1886-87. The skeleton is preserved in the Plymouth Museum. The skin was presented to the Exeter Museum.

September 1889 I heard from my former pupil, Mr Charles Anderson, M.B., of Hillswick, Shetland, to whom I have been indebted on several occasions for specimens of Cetacea, that a school of dolphins, nine or ten in number, had been chased off Hillswick by the fishermen, and that six of them—four females and two males—had been captured. From the general colouring and the peculiar light streaks and spots scattered over the surface of the body, from the shape of the snout, the large relative size of the dorsal fin, the absence of teeth in the upper jaw, and the presence of only three or four in the mandible, and from the length of the animals, which varied from 8 feet 7 inches to 10 feet 5 inches, Dr Anderson was led to believe that these Cetacea were Risso's dolphins. This important information he at once telegraphed to the Anatomical Museum of the University, so that we were enabled to secure the crania of four specimens and the carcases of two others. Owing to the steamer not calling at Hillswick for a fortnight after the capture, and the objection made by the captain to convey, on account of their odour, the entire carcases, they had to be eviscerated, cut into segments and packed in salt in barrels. I was unable, therefore, to obtain either drawings of or a complete view of these animals; but there could be no doubt, from the general form and from the marks on the skin, that they had closely resembled in appearance, and were the same species as, the *Grampus griseus*, so beautifully figured by Professor Flower in his memoir already referred to. This conclusion was confirmed by the anatomical examination to which they have been subjected.

A customary habitat of Risso's dolphin would seem to be the Mediterranean, in which sea it has been taken as far east as the Adriatic and as far south as the coast of Algiers and Morocco, whilst Risso stated that it frequented the northern shore about Nice at the pairing season, and Paul Gervais has recorded the presence of a school in the mouths of the Rhone. Professor P. J. van Beneden, in his "Histoire naturelle des Delphinides des Mers d'Europe,"[1] gives it a much wider distribution, for specimens, he says, have been captured at

[1] Bruxelles, 1889.

the Azores, the Cape of Good Hope, Japan, the North American seaboard, and even New Zealand. Mr F. W. True states that in the national collection at Washington, U.S., there are four adult skeletons, ten skulls, and some casts of heads and animals. All the specimens were from Cape Cod, Massachusetts, where they were obtained in the fall of 1875.[1] Heilprin also describes[2] the stranding of a more recent specimen on the North American coast. The grampus preserved in the museum at Wellington, New Zealand, by the name of *Grampus richardsoni*, is probably *Grampus griseus.*

The periods of the year in which specimens have been taken have been very variable. This dolphin has been captured at Algiers in January, at Nice in June, at Palermo in July, on the coast of the Gironde in April and July, off La Vendée in June, at Concarneau, Brittany, in September, in the Bay of St Michel in August, on the coast of Holstein and off the Eddystone Lighthouse in February, and at Sidlesham, on the coast of Sussex, in July, whilst the specimens from Shetland recorded in this communication were not taken until September. Nothing definite, therefore, can be said as to the migrations of this dolphin. It is, however, interesting to note that the Shetland capture was not that of a solitary animal, but of a school which had wandered northward, probably in the track of the Gulf Stream.

The dentition of this dolphin has always been a noticeable character. No teeth have ever been seen projecting through the gum in the upper jaw, and the number visible in the mandible has varied from two to six on each side. In the Shetland skulls two possessed the dental formula $\frac{0-0}{4-4}$ and four the formula $\frac{0-0}{3-3}$, which seem to be the most usual number.

[1] See Bulletin of the United States National Museum, No. 36; the family Delphinidæ, by F. W. True. Publications of Smithsonian Institution, Washington, 1889; also Professor Cope in Proc. Phil. Acad., 1876, pl. iii.

[2] Proc. Phil. Acad., 1887, p. 49.

The following are some of the principal measurements of one of the adult crania :—

	Foot.	Inches.
Condylo-premaxillary length in straight line,	1	7¾
Length of beak,	0	10
,, superior maxilla,	1	5¼
,, premaxilla,	1	3½
Anterior border of foramen magnum over vertex to tip of beak,	1	11¼
Anterior border of foramen magnum to upper border of occiput,	0	4¾
Greatest breadth of skull,	1	2½
Breadth between middle of orbital borders of frontals,	1	2
Length of mandible along outer surface,	1	4
Greatest breadth of the beak,	0	8
Height from basi-occipital to vertex,	0	8

The skull showed considerable obliquity in the naso-maxillary region. The slope of the mesethmoid was directed upwards and to the left; the right nasal bone was larger than the left, and each nasal was apparently divided into two lateral halves by an intermediate suture. The upper end of the right nasal was to the left of the mesial plane, and the posterior end of the right premaxilla was separated from the right nasal by a very narrow portion of the superior maxilla, whilst on the left side a much broader part of the superior maxilla intervened between the right premaxilla and nasal.

The stomach has been described both by M. Fischer[1] and Dr Murie,[2] and has been shown to resemble that of *Globicephalus melas.* My observations have led me to the same conclusion. It may suffice, therefore, if I state that it consisted of five compartments—*a*, a large œsophageal paunch lined by a prolongation of the œsophageal epithelium; *b*, a large cardiac or true digestive chamber; *c*, a small compartment which communicated with *b* and *d*; *d*, a globular compartment about the size of a large orange; *e*, an elongated compartment with a pyloric valve, from which the dilated commencement of the duodenum arose, the latter of

[1] Annales des Sciences naturelles, viii., Zoologie, 1867.

[2] Journal of Anat. and Phys., Nov. 1870, vol. v.

which received on its dorsal aspect the conjoined pancreatico-hepatic duct. The œsophageal paunch contained several pints of fluid, with the beaks and eyes of cuttle-fish. The cardiac chamber contained the partially digested mantles of thirty-four cuttle-fish, with quantities of eyes and beaks.

The intestine contained mucus; at the duodenal end it was fawn or salmon coloured; lower down it was bile stained; but in the last few feet it was stained a rich brown colour. From its tint I was led to think that it contained sepia, derived from the ink-bag of the cuttle-fish, on which the animal fed. The coloured mucus was digested in water, when the colouring matter was dissolved. It was then precipitated from the aqueous solution by the addition of spirit, when a rich brown pigment was obtained, possessing the properties of sepia, and which was subsequently used in the preparation of some drawings of the animal's viscera.

From the fact that the mucus, in something like the upper three-fourths of the intestinal tract, was unstained by sepia, it would seem as if the wall of the ink-bag had remained unruptured, and its contents undiffused through the mucus, until it had passed along a large part of the intestinal tube.

It has been shown by myself and others that cuttle-fish are a not unusual food for toothed whales. This has long been known as regards Hyperoodon, in the stomachs of several specimens of which the horny beaks and other parts of cephalopods have been seen.[1] Mr Beale states[2] that the food of the sperm whale consists almost wholly of the "squid" or "sepia octopus," though at times when near the shore it may take bony fish; Mr Bennett, in his "Whaling Voyage,"[3] confirms the statement that the main food is cuttle-fish, and he also mentions that he has seen a bony fish which was ejected from the stomach of a sperm whale on being attacked. From my own dissection I have reason to think that Sowerby's whale may also feed on cuttle-fish. Mr Robert Gray has repeatedly found the remains of cuttle-fish, probably *Gonatus fabricii*, in the stomach of the

[1] See Gray's Catalogue of Whales and Seals; also my paper on the Stomach in Ziphioid and Delphinoid Whales in Jour. of Anat. and Phys., vol. xxiii.

[2] The Sperm Whale, London, 1839. [3] London, 1840.

narwhal.[1] The horny beaks of cephalopods were seen by M. Fischer and Mr Lee in the stomachs of the two specimens of Risso's dolphin which they examined. Dr Charles Anderson observed that, as the fishermen opened the stomachs of this dolphin at Hillswick, they contained cuttle-fish; my dissections confirmed this observation. Four of the specimens of the cuttle-fish obtained in the stomach of Risso's dolphin were so far undigested as to enable me to count ten arms projecting from the ring around the mouth. Two of the arms were in three of the specimens much longer than the others, and were separated from each other by two short arms, but the suckers had disappeared in the digestive process. The remains of a pair of wings were attached to the mantle, and I thought that the animals were species of Loligo; but Mr W. E. Hoyle, to whom I referred the specimens for identification, regards them as the *Gonatus fabricii* of Lichtenstein. Mr Thomas Anderson has recently communicated to me an interesting fact, which adds another dolphin to the feeders on cuttle-fish. A few months ago a large school of the pilot whale (*Globicephalus melas*) was chased ashore at Hillswick, and on cutting out the viscera the partially digested skins and numerous beaks of these cephalopods were seen in the stomachs. It was also observed that the shallow bay into which these dolphins were driven was strewn with the undigested skins of cuttle-fish, as if the whales in their fright had ejected a portion of the contents of their stomachs.

(Some notes on the visceral anatomy of these dolphins are to be printed in the *Journal of Anatomy and Physiology*, January 1892.)

[1] Zoologist, April 1887 and 1889; in addition he found blood-red crustaceans, mostly *Pasiphaë tarda*, an abyssal form.

XII. *The Ethnology and Climatology of Central Africa.*[1] By R. W. Felkin, M.D., F.R.S.E., F.R.G.S. Etc. [Plates III.-VII.]

(Read 16th March 1892.)

There is much that is interesting and instructive in the climatology and ethnology of any country, and these subjects in reference to Africa could undoubtedly form the text of a lengthy discourse—firstly, because the climatology of this continent is only now becoming comprehensible; and, secondly, because there are in Africa many races which may be classed as primitive, uncontaminated as yet by the gloss of civilisation, and having customs and traditions which are the pure product of natural development. Reclus, in a book recently published, gives one or two happy definitions which I will quote:—"The new-born science of ethnography may, I think, be considered as the psychology of the species, just as demography may stand for its physiology, and anthropology represent an enlarged sort of anatomy. Demography and ethnology study the great facts of nutrition and reproduction, of nativity and mortality—one of the physical, the other of the moral nature of man. Demography compares statistical data, arranges them in series, finds out their agreements and their contrasts, lays bare many a modality of life hitherto unknown or ill-understood. Making big figures into an instrument of mathematical exactitude, it, like the Pythagoreans, has taken for its motto 'Numero pondere mensura.' Ethnography, too, has its large totals—manners and customs, faiths and religions; ages upon ages, tribes, peoples, and nations—such are the quantities with which it deals, quantities at once algebraic and concrete."

Civilised races are far too prone to forget that their institutions are not the progress of spontaneous generation, but that they are derived from a long-forgotten past; indeed, it is perhaps incorrect to use the term long-forgotten, for if we had time to examine into the traditions, superstitions, and customs even of your enlightened Scotland, we should find

[1] The best book of reference on the subject of this paper is The Development of Africa, by A. Silva White, F.R.S.E., second edition.

that in many respects the Scots are as superstitious as many of the Central African tribes, that some of their customs are almost as barbarous, that their traditions point to the unmistakable fact that they have a common origin with the primitive folk, and that their nineteenth century civilisation is only a more rapid development of the capabilities possessed by the Central African of to-day. This, doubtless, may not be at once apparent; but in speaking to such an audience, I need only remind you that the telescope, the microscope, and spectral analysis have done much to elucidate an exact comprehension and knowledge of physical science. In a similar way, by utilising the means we have at hand for investigating primitive nations, we may dissipate preconceived conceptions and ascertain the truth, although the truth may often be a severe blow to our self-conceit, for it will assuredly prove that there is remarkably little difference between the son of the bondmaid and the son of the free.

Before making any remarks upon the ethnology of Africa, I shall refer to its climatology, for this very good reason—the knowledge of climatology is necessary in order to enable us to understand the mental, moral, or even physical condition of any race, for climatology comprehends a considerable amount of knowledge. It not only refers, as is so commonly understood, to mere weather, but comprises the knowledge of the situation of a place upon the globe, its altitude and the configuration of the surrounding country, its means of communication with other districts or lands; its meteorology, that is to say, the temperature, rainfall, barometric pressure and winds; its geology, and, in addition, its state of cultivation, its capacity for cultivation, its condition with respect to animal life, and the density or otherwise of its population.

We find that Central Africa presents striking peculiarities in most of the points I have mentioned above. It forms, as it were, an isolated entity, cut off from communication with the rest of the world, both civilised and uncivilised, by its peculiar physical conformation. Roughly speaking, we can describe Central Africa, as I think was first done by the late Colonel Grant, by comparing it to a soup-plate turned upside down. The rim of the soup-plate represents the low-lying

coast region; we then come to the slopes leading up to the plateau, while the bottom of the soup-plate represents quite conveniently the Central African plateau. We have only to imagine upon this plateau three or four mountainous masses, and four rivers which rise in the Central African lakes, cutting their way through the rock-bound borders of the plateau to find their way through gorges, and over rocky beds, to the sea and ocean surrounding the continent.

Now it is due to these facts, thus briefly stated, that the entity of Central Africa has been maintained for centuries. The low-lying coasts, with pestiferous marshes and wide tracts of malaria, have prevented much intercourse between the highlands and the coast; and the fact that the navigation of the Nile, the Congo, and the Zambesi is impeded by cataracts of no slight magnitude, has prevented more highly civilised nations overrunning the country as they have done in North America and elsewhere. It may be objected that Central Africa might have been reached from the Cape in the south, and from the Mediterranean in the north. Here, however, climatology again shows us that this is impossible, for we have the great Sahara barring the entrance from the Mediterranean littoral in the north towards the centre, while easy access from the Cape is rendered almost impossible on account of the tzetse fly and the malarious regions south of the Zambesi.

A few brief details may not be out of place with regard to Africa as a whole. The vast country was known as the "world's end" in mythological writings, the term being a practical prophecy, it being the last continent to be explored. It has an area of 12 million square miles; it is 5000 miles long and almost 5000 miles at its greatest breadth. It is three times as large as all Europe, four times as large as Australia, and has a remarkable coast-line of only 17,700 miles in length, this being out of all proportion to its vast area, owing to the absence of bays, inlets, or estuaries, and in consequence there is no easy access to the interior of the continent.

Africa has been likened to a shapeless mass, but this is hardly accurate. As you may see upon the map, the eastern

coast-range, running parallel to the Indian Ocean, forms its backbone, broken only by the Limpopo, Zambesi, and Juba rivers, Kilimanjaro and Kenia being the highest points. Another range is found to the west of the Victoria Nyanza, Mfumbiro, Ruwenzori, and Gambarabara being the highest peaks. This mountain range separates the great river systems. The mean elevation of the whole continent is greater than that of Europe or Asia, although it does not possess such high mountains. Indeed, if an oblique line be drawn from Loanda to Suakim, we find that it passes through a tableland varying in height from 3000 to 4000 feet. To the north and west the Nile and Congo drain a third of the continent. It is remarkable to notice that the three great rivers —the Nile, the Congo, and the Zambesi—almost flow from the same spot, so low is the watershed. I may remark in passing that the Zambesi drains 750,000 square miles to the east, and the Orange River some 400,000 square miles to the west, but little of this water flows to the sea.

The meteorological conditions of the continent are distinguished by the regularity of the phenomena of weather, a regularity due to its massive form and equatorial position. When we examine the map showing the mean annual temperature, we find that it is very high; between the Tropic of Cancer in the north and the Orange River in the south it is 80° F. And even during the most favourable months in the year, February and August, in the north and south respectively, it is only at high altitudes and in very small areas that a temperature of 60° can be found. Along the coast-line the temperature is naturally influenced to some extent by the proximity of the ocean, but towards the east the sea has not a modifying effect, but increases the temperature by some 5 to 10 degrees. The highest temperatures in Central Africa are to be found in two zones—one to the north of the equator, around the sources of the Nile, and the other between Lake Tanganyika and the Orange River, in both of which places the temperature is over 90° for a great part of the year. With regard to winds, the trade winds are the most important; north of the equator the prevalent trade winds are from the north-east; south of it, from the south-east, with an intervening

belt of calms at the equator. These winds naturally distribute the rainfall, but the distribution is unequal, for we can find regions in Africa where there are under 4 inches of rainfall, and others where there are over 100. Speaking generally, however, it will be seen that in Central Africa the annual rainfall may be estimated at from 50 to 60 inches. The rainfall at the equator is pretty evenly distributed throughout the whole year, but north of the equator, at about 15°, there are two well-marked wet seasons.

The heat, rainfall, and winds affect the fertility of the country, and the whole region may be divided as follows:—36·4 per cent. is occupied by deserts, 14·6 by steppes, 5·3 by scrub, 21·3 by savannahs, 21·8 by forests and cultivated land, and 6 per cent. by the larger lakes.

It follows that half the continent is occupied by deserts and steppes, while less than a quarter consists of fairly fertile lands, of which a large portion is covered with forest. The typical zones of vegetation in Africa are—firstly, the Mediterranean zone, having a vegetation similar to that of Southern Europe, if somewhat more tropical; secondly, the Sahara desert zone, of which much might be cultivated, and where undoubtedly numerous oases exist; thirdly, the zone of tropical vegetation, more or less coincident with the highest mean annual temperature and heaviest rainfall; and lastly, the south central and South African savannah zone. Practically speaking, we may say that vegetation is richer as we proceed from south to north, and also from west to east. The mammalian fauna of Africa are exceptional, but I have only time to mention the hippopotamus and giraffe, the elephant, various species of antelope, the buffalo, zebra, and wild ass; beasts of prey—the lion, leopard, panther, hyena; numerous apes, chimpanzees, and gorillas. The bird fauna of Africa are not rich, but the reptile fauna are largely developed. Vipers of the most deadly kind, such as the puff-adder, are encountered, while crocodiles abound in all the larger rivers. Insect life is very abundant; locusts form a plague in some parts; and the tzetse fly, the bite of which is fatal to horses, oxen, sheep, and dogs, infests large parts of the country which are uncleared.

The average population of Central Africa may be estimated at about twenty to the square mile; and Mr Ravenstein estimates the total population of the whole continent at 127 million, with a rate of increase of 10 per cent. per decade. Boehm and Wagner estimate the population at 205 million. Both these estimates, however, are mere guesses.

The people of Northern Africa were probably in prehistoric times of the same ethnical stock as that of the peoples inhabiting Southern Europe. The Arabs who are found in the deserts of the Soudan are probably all descendants from the proto-Semitic stock. For the rest, we have Negroes of various kinds, but all distinguished by projecting jaws, flat features, broad noses, woolly hair, shining skin and pouting lips, and it is probable that they are all of one origin. We have also in Africa the Bushman, Tikki-tikki and Akka dwarfs, who are probably the oldest primitive people in Africa; it is curious to notice that they live alongside of the gorillas; thus the two orders of primates approach nearest one another in this continent.

There are various ways of classifying the ethnographic distribution of the African population. At present probably the best way is to base the subdivision upon linguistic facts. There are, according to Cust, no less than 438 languages and 153 dialects spoken in Africa. You will see on the map the relative positions occupied by people speaking cognate languages, and it is probably best to take Müller's classification of distinct ethnic groups as follows:—

1. The Semitic family, along the north coast of Africa and in Abyssinia.

2. The Hamitic family, who live mainly in the Sahara, Egypt, Morocco, Algeria, and in the Galla and Somali districts.

3. The Fulah and Nuba groups, who live in the western, central, and eastern Soudan.

4. The Negro groups, in the western and central Soudan, in Upper Guinea, and the Upper Nile region.

5. The Bantu family, everywhere south of 4° N. lat., except in the Hottentot domain.

6. The Hottentot group, in the extreme south-western

corner of Africa, from the Tropic of Capricorn to the Cape; and to this I should add the Tikki-tikkis and Akkas, living in scattered groups to the north of the equator.

I have only time to refer in detail to some of the peculiarities of the ethnography of the people inhabiting Central Africa, but, before passing on, I may just allude for a moment to the religions, which are roughly divided into six groups upon the map. The boundaries marked on it separate fairly accurately the Nature worshippers from the Moslems, the Monophysites or Gnostics from the Protestants, the Catholics and Jews.

Considering now the inhabitants of Central Africa, we have three groups, or practically three ethnic entities, to deal with. They are, it is true, divided into an immense number of different tribes, but although the manners and customs of these smaller divisions are very various, yet in broad outlines the groups are distinct enough. We have accordingly the Negro group in the northern part of Central Africa, the Bantu group extending far to the south, and the group of Hottentots in the south-west, to which must be linked, as I before indicated, the various dwarf tribes scattered in small communities in the Congo and Nile districts.

Generalising, one may say that the Negroes have a well-developed muscular system; this is perhaps not so pronounced in the lower limbs as in the torso, which as a rule is so good that a sculptor could scarcely find a better model. The head is round, the features are strongly marked, the jaws project somewhat, the nose is broad and flattened, the hair black and woolly. The colour of Negroes varies from an almost perfect black to bistre brown. It has been often said that the Negro possesses a clumsy flat foot with a markedly projecting heel. This is not so naturally, and when one examines the feet of newly-born babies they are seen to be well formed, fairly well arched, and with no marked projection of the os calcis. It is only in later life, and as a result of their manner of living, that the feet lose their natural shape, and become to a certain extent ungainly. Looking at the mental characteristics of Negroes, we find them to be child-like, easily amused, easily aroused to passion. They possess

capabilities of high education, although it is a mistake to suppose that the average Negro child can be educated up to a European standard. Brilliant exceptions to this may be met with, but as a rule three generations will be necessary to develop the Negro to our standard. Up to the age of fourteen the young Negro will probably distance a European child in almost any brain work, but after fourteen a marked difference becomes apparent, and the light-skinned Caucasian shoots ahead of the dusky child of the tropics. The Negroes possess a lethargic constitution, due to those climatological factors to which I have referred; nature is so bountiful, that all their simple wants are supplied in abundance, without the necessity for cultivation of the soil; therefore they have no incentive to strenuous manual labour. Life amongst Negroes is simple; but by careful examination plenty of evidence can be found that they possess the rudiments of all the arts which have arrived at such perfection in civilised countries. Music, painting, dancing, dress—the four great arts—are all met with in different stages of development among these primitive races, and it is somewhat of a shock to our ideas to find that all these arts have one basis, namely, the attraction of the sexes. It is also curious to note that amongst primitive folk the idea of dress is more highly developed in man than in the woman, and I suppose there is no article worn in the west-end drawing-room of the present day which has not its prototype in the ornaments worn by savage warriors in Central Africa, decked so as to please the eye and charm the senses of their more simply attired female admirers.

In the religion of Negroes, germs of the greatest truths may be traced underlying the numerous and strange superstitions, and the to us barbarous ceremonies by means of which they invoke the aid of their deities.

The Bantu races resemble in many particulars the Negroes. In some respects they are more highly developed; for instance, their organisation in respect of government and war approaches more nearly to that of European systems of the sixth and seventh centuries; and by possessing a greater richness of language, and a somewhat greater brain capacity, they are more easily influenced by new systems either of

government or theology, and thus more easily adapt themselves either to the vices or the virtues of civilisation.

The Bushman, Hottentots, and other dwarf races vary considerably from their neighbours. We may take it, I suppose, that their average height is about 140 cm. They are thin, more prognathous than the Negroes, and their skin is a reddish colour. It is noteworthy, too, that the skeleton of the male and female varies remarkably little. The skeleton, too, is remarkably delicate, and the skull by no means so thick as that of the Negro. Their senses, such as sight and smell, are superior to those of the tribes surrounding them; but their mental capacity seems to be much inferior in quality, their habits and life probably tending to prevent their mental development.

It is my intention now to endeavour to illustrate in general terms the position which Central Africans hold as compared with Europeans. I have spoken of them hitherto as primitive people; I think it would probably be better to use the German expression "Naturvolke," or Nature's people; because the various terms in vogue, such as wild tribes, primitive people, lower races, are unscientific, and their use is apt to confer a reproach with it, a reproach to which I personally am inclined to object. Calling them "children of Nature," we find they are living lives untrammelled by the prejudices and customs which hedge us in. For centuries they have developed as the soil on which they live has developed; their minds have developed slowly but surely, uninfluenced by the storms of fanaticism or the strides of artificial culture. Their development is more that of the heart than that of the intellect; it is deep rooted, gradually progressive, and compares very favourably with the upas tree of civilisation. Therefore those investigating these races will be disappointed if they look for brilliant gloss, whereas if they seek for steady progress they will not fail to find it. Doubtless you are all conversant with two classes of men who have visited unfrequented parts of Africa. Some have only stayed for a few short months among the natives, and have returned for the most part strongly prejudiced against them. Barbarous, brutal, filthy, blood-thirsty—such

are the terms used in describing the people. On the other hand, there are those who have remained longer among them, and have learned to know them better, and these discover that underneath that which is repulsive there exists method and much material for instruction, and that the people themselves are found to be lovable instead of repellant. I suppose that nowadays no one would seek to find a proof in Central Africa that man has descended from the ape, for as Virchow, the great anthropologist, says, this idea is perfectly untenable. The gulf separating the lowest man and the highest ape cannot be bridged; and though one readily allows the difference between the highest civilised western and the lowest type of African, yet when one remembers that the Chinese and Mongolian are of the same race, and yet are at the opposite poles as far as civilisation is concerned, one cannot say that the difference in development is a proof of a different nature. It may be asked then, What is the character of the difference which exists between civilised and uncivilised people? It is in the more rapid development of language, religion, and political and commercial ideas that the difference is to be found. As Hamanns says, "Without speech we have no reason, without reason no religion, and without this threefold cord we have no ground for either intellect or social ties."

One is in the habit of speaking of Africans and cognate races as children, when comparing them with more civilised races, and this may be justifiable. They possess language, fire, weapons, and implements, but owing to climatological causes they have been kept in a condition of childhood, although it must be admitted that the possibility of rapid advance is theirs if they could be placed under more favourable circumstances. Culture means the sum total of all the intellectual conquests of time, but we are too apt to forget that this is only a superstructure built upon the childhood of the civilised nations now long since past. A highly cultured people may be likened to a mighty tree which, through hundreds of years of growth, has reached a stature and a permanence of character far above that of annuals, which, having a limited tenure of existence, grow rapidly,

bloom, and die. Having thus generalised, we find in Central Africa at the present day a picture of the development of the whole world. We see there various tribes who are influenced by, and whose development varies in the first place with, the stage to which agriculture has been developed. The higher the cultivation of the land, the greater the development of the people. The possession of land becomes to them valuable, and with its possession permanent homes and more or less settled government must follow. Then, again, when we come to look at the African tribes who are herdsmen and hunters, we find another stage has been reached, where the people are braver, and where, being used to the handling of weapons, a military organisation exists. Uganda and Unyoro are good examples of these peoples; and practically we may say that the tribes inhabiting the steppes and the more cultivated parts of the country occupy these two distinct platforms of development. In other regions the people have developed still further, and we find numerous examples in Africa of agricultural people being dominated by races of hunters and warriors, just as the Chinese are ruled by the Mandshu, the Persians by the Turkestans, and the Egyptians by Hyksos Arabs and Turks. The Central African natives may be compared to people living in an epoch when little is demanded from individuals, and, in consequence, no rapid progress is expected. When, however, in the progress of the world, nations migrated from climatological conditions where life was easy to those in which individual effort was compulsory, the battle between man and nature stimulated both the mental and physical powers of man to such an extent that rapid growth became not only possible but apparent.

Language gives us many clues to progress. We find in the languages and dialects of Africa all stages of development, from the lowest imaginable (that spoken perhaps by the Nuehrs and Dinka, and possibly also by Tikki-tikki) up to the highly systematised Bantu dialects, with their complicated inflexions and rich vocabularies. There is not however, in all Central Africa a written language, although we do at times find rough attempts at a picture language,

which is of course the origin of the written character and of the possibility of the written literature. Now, without a written literature the highest kind of civilisation is impossible, and there again we see how the Central African has been handicapped in the race with the nations of the world.

Passing on to religion, ethnography knows of no irreligious people, or perhaps I should say of no people without a religion. We find missionaries returning from Africa and telling us that the Africans possess no religion, but what could be greater nonsense? They do not possess anything approaching the great systematised religions of the world; but when we come to understand their ideas, we find that they have a religion and are influenced by it; that they live up to it, and that they are more consistent in it than the majority of those who possess the highest systematic religion known. I think it might be possible to prove that the religious ideas and beliefs which obtain in Central Africa are the result of a retrograde religious movement, such as we have exemplified in the Abyssinian or "Thomas" Christianity, or the Mongolian Buddhism; indeed, I cannot help thinking that the fetishes of the Negroes, and the belief in spirits of the Hottentots, point to this. We know the rapidity with which a religion can be propagated; we know also that systematic religions may dwindle, droop, and die; even the latest example, the change which has taken place only last year in the Mormon community, illustrates this sufficiently. Religion is bound up most intimately with the deepest needs of mankind. It is the result of the need which man feels to ascertain the cause of the effects which he perceives in his own life and surroundings. The cause of sunshine and showers, of growth and decay, of disease and death, and more than this, the first cause of everything. This being the case, it is only natural that an analogy should be sought by men in man for all the workings of Nature; and so we find that natural phenomena are supposed to be like men, possessed with soul and body, or nephesh and body—nephesh meaning the breath of life, that imponderable something which is life. So we find the Africans, when speaking of a plant which is dead, saying that its spirit or soul is departed,

just as when a man dies his nephesh is supposed to go to people the unknown, but definitely apprehended, spirit-world which not only surrounds but pervades the present world.

The question now naturally arises, Where do these people get the idea of the soul with which they believe all nature to be permeated? This leads up to the deepest, strongest origin of all belief, from which souls, spirits, ghosts in millions are ever rising. What are the impressions which are likely to be the most permanent or pregnant in those who possess an impressionable nature? Certainly those which affect them individually and definitely, such as sickness and death, hunger and thirst. Now it follows that such things as hunger and thirst, which are constantly occurring, do not affect the people so much as does death, which leaves a permanent effect; consequently the fear of nature is less than is the fear and horror of death and the dead. And here we find the origin of fetishism. The medicine-men are supposed to have a certain relationship with the departed; and not only is it supposed that the spirits of the dead may animate them, but also that they may take up a more or less permanent abode in inanimate things, such as stocks and stones. All kinds of burial customs in vogue have really a religious origin. The thought is ever present that the soul does not immediately depart from the dead body; and in many cases we find that, owing to the belief that the spirit haunts the neighbourhood of a grave, votive huts are built, where food is offered periodically. A little higher in the scale, we come upon distinct evidence of the definite belief in a life after death filled up with active deeds. Thus, in Uganda and Unyoro, and in many other tribes, we find the belief deeply rooted that the spirits of departed kings and chiefs still rule the destinies of the nation, take part in its victories and in its defeats; and in these countries a still higher development has been reached, for they recognise a supreme Being as the creator of the universe, and lesser deities to whom is given the power of life and death. Soon after these ideas, the belief in rewards and punishments after death is attained; but none of these people, so far as I am aware, possess any idea of a Judge, who awards either praise

or blame; and indeed no moral ideas, in our sense of the word, are involved in this stage of religion. Two classes of natural phenomena also deeply affect the minds of Central Africans, in common with all other races in the same stage of development. They possess a consciousness of individual insignificance, as compared with the power and might exhibited by Nature. The people are oppressed with a sense of their powerlessness in counteracting the influences of storms, earthquakes, etc., and are therefore prone to imagine that these phenomena are but the embodiments of spirits or individuals possessing superhuman powers. Thus one finds in almost every village charms or votive huts dedicated to the various elements; and in Uganda I often saw miniature huts built near places struck by lightning. No stranger may approach any such hut, but the natives in passing are accustomed to make an offering of a few beads or bananas to propitiate the awful thunder god. The other phenomena referred to are the movements of the heavenly bodies. They affect the undeveloped mind with as great an awe as they do those highly civilised individuals who really comprehend something of their magnitude. The warmth of the sun impels them to gratitude; the moon in her changing phases, to wonder and awe; the planets themselves are constantly the object of vague speculations; and starry pictures, formed by the phantasy of medicine-men and chiefs, are not only objects of veneration, but also in many cases are used as oracles, foretelling events or settling disputed points in policy.

One can summarise all religions somewhat as follows:—First, those religions which do not raise a god to a higher standard than a man, and are without a strong moral tendency. These rest entirely upon the belief of spirits and ghosts connected with rain-making, medicine, and fortune-telling, as well as a considerable amount of superstition. Upon this basis two distinct kinds of religious belief are built: (1) a strong disposition to fetishism, and (2) a higher development possessing cosmological and mythological ideas. Secondly, we have those religions which raise the Godhead far above the human being, accompanied by moral laws, a striving after right for right's sake, distinct ideas of a future

life, with reward for good and evil; and upon this basis we find polytheism, and, of course, monotheism, the highest development of all. This, however, except in very rare instances, is not to be met with in the country with which we are dealing.

I referred before to the rôle which agriculture plays in the development of races. Now in Central Africa, all things being equal, the higher the agriculture the higher the development of the people; and so too is it with wood-carving, pottery, the manufacture of weapons of war and for the chase, and the construction of traps for snaring birds or animals. I do not think that, in general, sufficient credit is given to Central Africans for the ingenuity which is expended upon all these arts. The pottery compares favourably with that of home manufacture in any part of the world. The wood-carving certainly falls behind, but the wicker-work and the various weapons are constructed tastefully, neatly, and with surprising skill. Indeed, when we compare articles of African manufacture with the products of the highest civilisation, we find that whereas in the latter the articles are brought to great perfection, yet in the former is to be found the fundamental idea which lies at the basis of all the various developments of which the industry is capable.

I must now devote a few words to the subject of clothing. I would first remark that clothing has nothing whatever to do with a standard of civilisation, and, as far as morals go, the absence of all clothing is a distinct advantage. I noticed over and over again in Africa the more clothed the person the more immoral and indecent the tribe. Those tribes possessing little or no clothing were far superior in these respects; for instance, in Uganda, although it is death for persons to be unclothed in the streets, as regards morality a more filthy people would be difficult to imagine. In a state of nature want of clothing has no drawbacks, and it is only when we come to the civilised races that we find clothes pandering to indecency of all descriptions. Clothing, both in its character, its extent, and method of fabrication, depends again upon climatological factors, and we see that according to the amount of rain-fall, of sunlight, of vegetation,

etc., the clothing is either constructed so as to shield the body from atmospheric influences or from external violence.

Turning to communal or tribal life, we find that in Central Africa all stages of development, from the family to the kingdom, are represented, and it is interesting to see the various stages out of which a state is evolved. *First*, we have the families grouped into villages, a village containing a group of families akin to one another. The people have found that a certain amount of order must be maintained; and therefore they elect a headman, who rules their small domain, whose word is law, and who, perhaps, combines with this communal headship priestly functions. In other districts we notice that villages become larger, and that the headman has two or three assistants to help him. We then come to villages banded together, owing to the inroads of neighbouring communities, and forming tribes, each with its own ruler, who lives in the largest village, and to whom all living in the surrounding area owe vassalage. Passing higher in our investigations, we come to kingdoms like that of Uganda, where the original village chief has attained to kingly rank, where hereditary chiefs support his authority, and where not only a small group of villages but an immense district is formed into one consolidated whole, with a population of some five or six million. And such a kingdom as this reminds one forcibly of what Great Britain was in the days of the feudal system. The constitution both of families and tribes and even kingdoms seemed based on the idea of a circle. In the family the father with his hut forms the centre; around it we have the huts of his wives and infants and children; around them again the grown-up children build their dwellings; and the same process goes on until we get the great chief, and surrounding him circles and circles of families and subdivisions of the tribe. In a kingdom such as Uganda a systematised government obtains; the king is his own minister of war; he has a council of war; each district is governed by a military officer; and each man capable of bearing arms is bound to answer the call, first of his chief, then of his district chief, and lastly of his king. These military functionaries in Uganda also administer the

law, both civil and criminal. But even the poorest man may appeal from his village court to the district court, and finally to the king in council. The legal procedure is characterised by rough and ready justice, and although men of business and advocates are unknown, yet trials are conducted with remarkable decorum and ability. It is most interesting to watch one of these trials, to witness the courteous bearing of the litigants, to hear the native eloquence with which they plead their cause, to comprehend the acute cross-examining of witnesses, and to see the way in which the people willingly submit to the judgment given in their cases. Writers tell us that the punishments inflicted in Central Africa are barbarous. This I fail to see. You cannot judge these people by nineteenth-century ideas, and their punishments compare, I believe, most favourably with those in vogue in ancient Greece and Rome. And when we remember the crimes for which the death penalty was administered in our own country within comparatively recent times, we must acknowledge that Central African justice is tempered with mercy. All this is a matter of pure comparison, and when we consider the state of development which these natives have reached, we cannot help being surprised at their enlightened condition.

Before concluding, I have to refer to the method which should be adopted in introducing both religion and civilisation into Central Africa.

The great mistake which is made in dealing with Central Africans is to thrust European opinions upon a people unprepared to receive them. One can lead where one cannot drive; and the only result of shaking belief, or of inculcating disrespect for law as it obtains, is to induce scepticism on the one hand, and lawlessness on the other. Respecting religion, I maintain that it is the duty of all missionaries, first, to make themselves thoroughly acquainted with the beliefs of the people they are sent to teach; and then to build upon them, and gradually to wean the people from their superstitions, and from the worship of the unknown God to the recognition of Christianity in its purity. The African of to-day, coming in contact as he

does with the various sects into which the Christian religion is divided, can only in his own mind come to the conclusion that we, as he, have gods many, and that our superstitions are as numerous and our customs as variable as his own. This should not be, and various sects should never be permitted to carry their bigotry and uncharitableness across the seas to unsettle native minds.

Respecting customs and laws, I hold that nothing should be done to undermine law and order until the people are ready for the change. The institution of polygamy itself should, I believe, remain untouched, for where is the morality of teaching that a man, who has entered into legal responsibilities of such a character, should all at once be induced to repudiate his obligations, and to cast forth from his protection and support those who have the best right to it? This is only one example from many which could be given, of the unthinking methods which are used by a civilised people in trying to reclaim, as they say, lower races.

XIII. "*The Raised Sea-Bottom of Fillyside*"—*Researches in* 1869-70 and 1888. By JAMES BENNIE, of the Geological Survey of Scotland; with Lists of the Mollusca by ANDREW SCOTT. [Plate VIII., Figs. 1-3.]

(Read 16th March 1892.)

The late Hugh Miller, on 17th December 1854, read a paper to this Society "On a Raised Sea-Bottom at Fillyside Bank, between Leith and Portobello," the title of which was only given in the *Proceedings*, vol. i., p. 5, but which was published in full in "Edinburgh and its Neighbourhood," in 1863. This paper I read shortly after its publication, and felt much interested in the things and conditions described in it; and resolved that, if fate gave me any chance, I would visit the place, and, for my own edification, have a rummage in this old sea-bottom. Accordingly, on my transference from Glasgow to Edinburgh in 1868, one of the first places I visited was Fillyside, and examined as I then best could the section and conditions exposed at that time. They were essentially the same as

Hugh Miller described, but with some differences, which, though they lessened the dramatic effect somewhat, did not violate in any degree the unities of time and space.

I found the upper Oyster-bed consisting of cast-up shells—the Littorina-bed and the lower bed an unctuous clay, the chief shell of which was *Trochus cinerarius*. I did not find stones with oysters adhering, nor any perforated by *Saxicavas*, nor yet *Myas* burrowing in the boulder clay, as Mr Miller so graphically describes.[1] This, of course, I regretted somewhat, as I would have liked much to have seen and found everything that Hugh Miller saw and found; but the regret was not great, as my purpose was not, like his, to prove that this bed was really a raised sea-bottom and not a mere heap of marine debris cast up by storm waves, as Professor Fleming and his school maintained all raised beaches were. My purpose was rather to apply to Fillyside the methods of researches I had been accustomed to, in examining the glacial marine clays of the Clyde beds—methods by means of which the minuter life of a past period can be found and examined as effectually as the muds and sands of recent sea-bottoms have been examined and studied by dredging. I was successful so far, for in the muds and sands of the raised sea-bottom of Fillyside were to be found not only the larger life remains that the finger and thumb could pick up, but also the more numerous remains of the minuter life which could only be detected by the hand-lens and determined by the microscope. Having realised this, I made several visits to Fillyside in 1869-70, and lifted many samples of its shelly sands and muds. The larger shells were named by R. Etheridge, jun., and placed in the Raised Beach case in the Museum. The minuter life remains—the small shells, the Ostracoda and Foraminifera, and a mass of woody debris—were laid aside till time or circumstances would bring to Edinburgh experts like those in Glasgow, such as Mr David Robertson, who could name and determine them. They have

[1] The reason why was doubtless that the tides and storms of the intervening fifteen years had washed away the layer of the boulder clay the *Myas* had burrowed in, and rubbed off the oysters from the stones Mr Miller found them adhering to in 1854.

waited long, and might have been waiting yet had not my memory been quickened by reading Mr Clement Reid's paper on some of the Norfolk Pliocene deposits, in which he gave lists of the seeds he had found in them, which reminded me that in the vegetable debris from Fillyside, lying by so long, were many seeds which might be determined as readily. I therefore hunted up the remainder of my gatherings in 1869-70, and subjected them to such new processes of cleaning and reassorting such material as I had learned in the interval, and found I could make much more of it now than I could in 1869-70. The mass of vegetable debris consisted chiefly of fragments of wood—all rounded and water-worn, same as small gravel, and much coated with iron rust. This I boiled in oxalic acid, which cleaned them thoroughly, and then I began to pick the seeds out of it. But besides the seeds I found fragments of mosses, elytra of beetles, and what surprised and delighted me greatly, many Carboniferous Lycopod spores.

Seeing such good results, I went back to Fillyside in 1888, and lifted several large lots, and washed and sorted the organic remains in the best way known to me. The material lifted in 1869-70 was from near the same place whence Mr Miller lifted the shells in 1854. The material lifted in 1888 was from a point a little farther to the east, but from the same positions as described by him; and also from nests of shelly debris on the top of a small cliff of boulder clay that rises a little above high-water mark, about a hundred yards still farther to the east.

Having narrated the circumstances that led to these researches, I will now briefly summarise the results obtained.

1. Relics of sea life. These consisted chiefly of shells. These Mr Andrew Scott has kindly undertaken to name, list, and describe, and to him I confidently assign them. The Ostracoda and Foraminifera are as yet undetermined.

2. Waifs from the land, chiefly crumbs of wood rounded by attrition; seeds, sprigs of mosses, and elytra of beetles. These waifs of the land were in greater numbers than we can suppose to have fallen into the sea accidentally from the land near the shore or been wafted into it by the winds, and I think they came in chiefly by a small burn, called in modern

days the Foul Burn, which runs into the sea only a few hundred yards farther to the west. At that time it was not foul but sweet, and sewerage was unknown in the land. The wood grit would likely long float and be driven about by waves and tides for many years ere it became water-logged and was buried up by the falling sand. The beetle remains would likely, as soon as they came into the sea, be limed on some muddy layer and be preserved from attrition, the only way they could perish, as by their nature they are proof to decay by the agencies that rot wood or dissolve shells.

The following is a list of the seeds kindly furnished by Mr Clement Reid, of the Geological Survey of England:—

Ranunculus Flammula, Linn.	*Taraxacum officinale*, Web.
,, *repens*, Linn.	*Stachys palustris*, Linn.
Viola sp.	*Ajuga reptans*, Linn.
Lychnis diurna? Sibth.	*Atriplex patula*, Linn.
Stellaria media, Cyr.	*Rumex* sp.
Montia fontana, Linn.	*Mercurialis perennis*, Linn.
Rubus Idæus, Linn.	*Alnus glutinosa*, Linn.
Sambucus nigra, Linn.	*Carex* sp.

The beetles are as yet undetermined. They are numerous and various, and would, I feel certain, prove a pleasing and instructive study to any entomologist who would undertake their examination.

3. Carboniferous Lycopod spores. These, though not so numerous as the other relics of the sea, were still in notable numbers, and, as they were the most bizarre of all, arrested attention in like degree. Besides, the ways and means by which they had come to Fillyside suggested imaginations far more romantic than any of the others, and I had infinite pleasure in realising them. They were in great variety and conditions, and had evidently suffered much attrition in their life in death during the Boulder Drift and Raised Beach periods. The kinds which had suffered most from tear and wear were the *zonales*—the stumps of the fringe of hairs only remaining, like headless baby pins in a liliputian button-shape pin-cushion. Many of them were *Triletes*, with the triradiate ridge clearly seen on the under side of the spore; some were *Lageniculæ*, with pustules still strongly marked.

The immediate source of the spores was, I concluded, the

boulder clay upon which the raised beach rested. It was a strong, stiff, almost rock-like mass, and came out from under the raised beach deposit, and is washed over by every tide and storm of the present day; and I could not doubt that it was also exposed in the same way during the times of the raised beach, and that the spores were then washed out of it and mingled with the shells and other life remains and buried with them in the bed then forming. But the primary source was the spore coals and fire-clays of the Midlothian Coal-Measures, which had suffered denudation in the Glacial period from iceberg, glacier, or ice-sheet, and in tracing their descent from their origin in Carboniferous times to the time when they turned up in the washings of sands or muds from Fillyside, with all the changes of scenes and circumstances through which they passed, "reason led," as Professor Playfair says, "where imagination dared not follow." Still it was a pleasure to attempt it.

First, in the warm atmosphere of the Carboniferous forest Lepidodendroid trees flourished luxuriantly, enjoying a sub-tropical sunshine which ripened their cones as summer mellowed into autumn, till they opened their scale-like bracts and gave birth to the matured spores which were to carry on the vegetable life of the world down the course of time. Some would by circumstances be elected to everlasting life, while many and those among others would be castaways and become buried in clay or turned into coal, and be lost for a long time, even measured geologically, æons upon æons past reckoning. But a time did come in which they were restored to the light of day by the resurrectionary forces of Glacial times tearing up the rock-fast places they were immured in and breaking the bands which held them and setting them free, not, however, to fructify and bring forth plants after their Carboniferous kind, but to be reburied in boulder-clay, shovelled aside into a colder grave, and with maimed funeral rites, utterly unlike the dainty burial they had in congenial Carboniferous times. But this second burial was not final; a more gentle resurrection awaited them in the more genial times of the raised beaches, and the clay which held them in durance this time

was subjected to denudation by the sea, or it may be by the gentle flow of "the streams which swift or slow draw down the æonian hills," and the spores were restored again to the light of day, and became the sport and playthings of tides and storms on the sea-shore for a time, but at last they were laid for a second time in a dainty grave with the dead shells of the Raised Beach period, where they lay till I came in 1869 or 1888 and blessed them with a resurrection which promises to be final as far as we can judge; but perhaps not, as the ways of Nature are the same now as in the beginning, and will be the same world without end. Who can say what vicissitudes may yet befall man's museums, or even man himself, in the changes yet to come!

Mr Kidston has kindly examined the spores from Fillyside, and been able to recognise nine forms, as follows:—

Triletes I., II., VI., XI. (grouped spores), XII., XIII., XIV., XV.

Lagenicula I.

Figures of the different forms may be seen in the plates by Mr Kidston attached to the paper "On Spores" in *Proceedings of the Royal Physical Society of Edinburgh*, ix., 83.

The following species of Mollusca are given by Mr Miller as found by him at Fillyside in 1854:—

Buccinum undatum.	*Saxicava rugosa.*
Littorina littorea.	*Tapes pullastra.*
,, *litoralis.*	*Venus perforans.*
Patella vulgata.	*Cardium edule.*
,, *pellucida.*	,, *echinatum.*
Purpura lapillus.	*Ostrea edulis.*
Nassa incrassata.	*Scrobicularia piperata.*
Turretella communis.	*Nucula nucleus.*
Trochus cinerarius.	*Tellina solidula.*
Murex erinaceus.	*Pecten opercularis.*
	,, *pusio.*
	Mya truncata.
(*Serpula* and *Lepralia*)	*Solen siliqua.*
	Anomia ephippium.

The following is a list, by Mr Andrew Scott, of the shells observed in the material from the Raised Beach at Fillyside. The classification and nomenclature followed is that adopted by Dr Jeffreys in his "British Conchology":—

Order LAMELLIBRANCHIATA.

Family ANOMIDÆ.

Anomia ephippium, Linne.

Anomia ephippium, Linn., Syst. Nat., p. 1150.
,, ,, F. and H., vol. ii., p. 325, pl. lv., figs. 2, 3, 5, 7.
,, ,, Jeffrey's Brit. Conchology, vol. ii., p. 30; vol. v., pl. xx., fig. 1.

Rather rare in the material. As a fossil this species has been obtained at Cocklemill Burn, near Largo, in the Post-Tertiary clays of the Clyde beds, and at various other places in Scotland. In England it appears to be of frequent occurrence in the Newer Tertiaries as well as in the Coralline Crag. It has also been observed in Ireland in the marine accumulations at Portrush, County Antrim; Belfast, etc.

As a living species *Anomia ephippium* is widely distributed in the European seas from Iceland to the Ægean Archipelago.

The following varieties were also observed :—

Anomia ephippium var. *aculeata*, Linn. Frequent.
,, ,, ,, *squamula*, ,, ,,

CLASS CONCHIFERA.

Family PECTINIDÆ.

Pecten opercularis (Linn.).

Ostrea opercularis, Linn., Syst. Nat., p. 1147.
Pecten opercularis, F. and H., vol. ii., p. 299, pl. l., fig. 3; pl. li., figs. 5 and 6; pl. liii., fig. 7.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 59; vol. v., pl. xxii., fig. 3.

Not common. The fossil distribution of this species is similar to the last. As a living species it is common all round the British coast, very common in the Firth of Forth.

Family MYTILIDÆ.

Mytilus edulis, Linne.

Mytilus edulis, Linn., Syst. Nat., p. 1157.
,, ,, F. and H., vol. ii., p. 170, pl. xlviii., figs. 1-4.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 104; vol. v., pl. xxvii., fig. 1.

Common. As a fossil it is found in all the Post-Pliocene clays of the British islands, and as a living species it is abundant everywhere.

Modiolaria marmorata (Forbes).

Mytilus marmoratus, Forb., Mal. Mon., p. 44.
Crenella marmorata, F. and H., vol. ii., p. 198, pl. xlv., fig. 4.
Modiolaria marmorata, Jeff., *loc. cit.*, vol. ii., p. 122; vol. v., pl. xxviii., fig. 1.

Rare. This species does not appear to be very common as a fossil; it is recorded from the estuarine clays of Belfast and Larne Lough in Ireland, from the Red and Coralline Crag in England.

As a living species *Modiolaria marmorata* is found on all the British coasts, attached to old shells or imbedded in the skin or outer integument of ascidians.

Family ARCIDÆ.

Nucula nitida, G. B. Sowerby.

Nucula nitida, Sow., Conch. Ill. (Nucula), p. 5, fig. 20.
,, ,, F. and H., vol. ii., p. 218, pl. xlvii., fig. 9.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 149; vol. v., pl. xxix., fig. 3.

Not common. It has been obtained as a fossil at Cocklemill Burn, near Largo, and in the deposit at Paisley.

This species is found living on most of the British coasts but nowhere abundantly.

Leda pygmæa (Münster). **Leda,** Schumach.

Nucula pygmæa (Münster), Goldfuss, Petref., p. 157, t. cxxv., fig. 17.
Leda pygmæa, F. and H., vol. ii., p. 230, pl. xlvii., fig. 10.
" " Jeff., *loc. cit.*, vol. ii., p. 154; vol. v., pl. xxix., fig. 5.

Rare. This species has been obtained in a fossil condition in the Post-Pliocene clays of the Clyde beds, at Montrose, Elie, and Errol, etc.

In its living state it appears to be very local in its habit.

Leda minuta (Muller).

Arca minuta, Muller, Prodr. Zool. Dan., p. 247, No. 2985.
Leda caudata, F. and H., vol. ii., p. 226, pl. xlvii., figs. 11-13.
" *minuta*, Jeff., *loc. cit.*, vol. ii., p. 155; vol. v., pl. xxix., fig. 6.

Rare. Its fossil distribution in Scotland appears to be more limited than *L. pygmæa*, and has been recorded from Elie and Errol, and from the boulder clay at Caithness. On the west coast it has been obtained from the deposit at Bute. It has been recorded from the estuarine clays at Belfast in Ireland.

Family KELLIIDÆ.

Lepton nitidum, Turton. **Lepton,** Turton.

Lepton nitidum, Turt., Conch. Dith., p. 63.
Kellia nitida, F. and H., vol. ii., p. 92, pl. xxxvi., figs. 3 and 4; and (*L. nitidum*), Appendix IV., p. 225.
Lepton nitidum, Jeff., *loc. cit.*, vol. ii., p. 198; vol. v., pl. xxxi., fig. 3.

Frequent. As a Post-Tertiary fossil this species has been found in the clays at Garvel Park, Greenock; it also occurs as a Coralline Crag fossil.

In a living state it is not uncommon on the British coasts.

Montacuta bidentata (Montagu). **Montacuta** Turton.

Mya bidentata, Mont., Test. Brit., p. 44, t. 26, fig. 5.
Montacuta bidentata, F. and H., vol. ii., p. 75, pl. xviii., figs. 6 and 6*a*.
" " Jeff., *loc. cit.*, vol. ii.

Frequent. As a fossil it has been found in the marine accumulations at Largo, Fifeshire; in the Clyde beds at

Greenock and Dalmuir. In England it has been found in the Coralline Crag, etc.

In a living state it is found everywhere from Shetland to the Channel Islands.

Family CARDITIDÆ.

Cyamium, Philippi.

Cyamium minutum (Fabricius).

Venus minuta, Fab., Faun. Grœnl., p. 412.
Turtonia minuta, F. and H., vol. ii., p. 81, pl. xviii., figs. 7 and 7*a*.
Cyamium minutum, Jeff., *loc. cit.*, vol. ii., p. 260; vol. v., pl. xxxiii., figs. 5 and 5*a*.

Frequent. This species has been obtained as a Post-Tertiary fossil in the Clyde beds at Greenock and West Loch Tarbert.

In its living state it is comparatively common everywhere.

Family CARDIIDÆ.

Cardium, Linne.

Cardium fasciatum, Montagu.

Cardium fasciatum, Mont., Test. Brit. Suppl., p. 30.
,, ,, F. and H., vol. ii., p. 25, pl. xxxii., fig. 5.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 281; vol. v., pl. xxxv., fig. 3.

Moderately common. As a Post-Tertiary fossil it has been recorded from the deposit at Largo, and from the Clyde beds. It has also been obtained in the Coralline Crag.

As a living species it appears to be generally distributed.

Cardium nodosum, Turton.

Cardium nodosum, Turt., Conch. Dith., p. 186, t. 13, fig. 8.
,, ,, F. and H., vol. ii., p. 22, pl. xxxii., fig. 7.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 283; vol. v., pl. xxxv., fig. 4.

Rare. A single specimen apparently belonging to this species was obtained.

Family VENERIDÆ.

Venus lincta, Pulteney.

Venus, Linne.

Venus lincta, Pult., in Hutch. Dors., p. 34.
Artemis lincta, F. and H., vol. i., p. 431, pl. xxviii., figs. 5 and 6.
Venus ,, Jeff., *loc. cit.*, vol. ii., p. 330; vol. v., pl. xxxviii., fig. 2.

Rare. As a fossil this species has been recorded from the estuarine clays at Belfast, Ireland; from Dalmuir; from the boulder clay at Wick; from the redeposited crag bed of Aberdeenshire; and from the Red and Coralline Crag.

In its living condition it is found on every part of the British coast.

Venus fasciata (Da Costa).

Pectunculus fasciatus, Da Costa, Brit. Conch., p. 188, tab. xiii., fig. 3.
Venus fasciata, F. and H., vol. i., p. 415, pl. xxiii., fig. 3; pl. xxiv., fig. 7.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 334; vol. v., pl. xxxviii., fig. 4.

Not common. As a Post-Tertiary fossil this species has been obtained in the deposit at Ayr; in the estuarine clays at Portrush, County Antrim; and in the Coralline and Mammalian Crag.

As a living species it is common everywhere.

Tapes pullastra (Montagu).

Tapes, Mühlfeldt.

Venus pullastra, Mont., Test. Brit., p. 125.
Tapes pullastra, F. and H., vol. i., p. 382, pl. xxv., figs. 2 and 3.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 335; vol. v., pl. xxxix., fig. 6.

Rather rare. This species has been obtained in the deposit at Largo; in the estuarine clays at Portrush, County Antrim, and Belfast; and from the Tertiary beds at Sussex.

In its living condition it is found on all the British coasts.

Family TELLINIDÆ.

Tellina, Linne.

Tellina tenuis, Da Costa.

Tellina tenuis, Da Costa, Brit. Conch., p. 210.
,, ,, F. and H., vol. i., p. 300, pl. xix., fig. 8.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 379; vol. v., pl. xli., fig. 1.

Moderately common. As a fossil this species has been obtained in the marine accumulation at Largo, in the Post-Tertiary clay at Kyles of Bute, and in the estuarine clay at Belfast.

This species is found living on all sandy beaches at low water mark.

Tellina fabula, Gronovius.

Tellina fabula, Gron., Zooph., vol. iii., p. 268, t. 18, fig. 9.
,, ,, F. and H., vol. i., p. 302, pl. xix., fig. 9.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 382; vol. v., pl. xli., fig. 2.

Rare. In its fossil condition this species has been observed in the accumulation at Largo; in the Post-Tertiary clays of the Clyde beds at Garvel Park, Greenock, and Loch Gilp; and in the estuarine clay at Belfast.

This species is found living in sandy bays all round the British coasts.

Family MACTRIDÆ.

Mactra, Linne.

Mactra solida, Linne.

Mactra solida, Linne, Syst. Nat., p. 1126.
,, ,, F. and H., vol. i., p. 351, pl. xxii., figs. 1-5.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 415; vol. v., pl. xliii., fig. 2.

Common. Young specimens, apparently belonging to this species, were observed in the material.

Mactra subtruncata (Da Costa).

Trigonella subtruncata, Da Costa, Brit. Conch., p. 192.
Mactra subtruncata, F. and H., vol. i., p. 358, pl. xxi., fig. 8; pl. xxii. fig. 2.
,, ,, Jeff., *loc. cit.*, vol. ii., p. 419; vol. v., pl. xliii., fig. 3.

Rather rare. As a Post-Tertiary fossil this species has been obtained at Largo, and in the Clyde beds at Bute, Cumbrae.

This is widely distributed as a living species.

Scrobicularia alba (Wood). **Scrobicularia,** Schumacher

Mactra alba, Wood, in Linn. Trans., vol. iv., p. 165, t. xvi., figs. 9-12.
Syndosmya alba, F. and H., vol. i., p. 316, pl. xvii., figs. 12-14.
Scrobicularia alba, Jeff., *loc. cit.*, vol. ii., p. 438; vol. v., pl. xlv., fig. 3.

Rare. This species has been obtained in the Clyde beds at Greenock, West Loch Tarbert, etc.; in the estuarine clays at Belfast and Larne Lough; it also occurs in the Coralline Crag.

Scrobicularia alba is found living in the mud of estuaries creeks, and bays on all the British coasts.

Family MYIDÆ (MYADÆ).

Mya arenaria, Linne. **Mya,** Linne.

Mya arenaria, Linn., Syst. Nat., p. 112.
,, ,, F. and H., vol. i., p. 168, pl. x., figs. 4-6.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 64; vol. v., pl. l., fig. 1.

Not common. This species has been recorded as fossil from the Clyde beds at Bute and Loch Gilp; from the estuarine clay at Belfast; and from the Red Crag.

It is found living all round the British coasts.

Family SAXICAVIDÆ.

Saxicava rugosa (Linne). **Saxicava,** Fleurian de Bellevue.

Mytilus rugosus, Linn., Syst. Nat., p. 1156.
Saxicava rugosa, F. and H., vol. i., p. 146, pl. vi., figs. 7 and 8.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 81; vol. v., p. li., fig. 3.

Frequent. As a Post-Tertiary fossil it has been found in the Clyde beds at Greenock, West Loch Tarbert, etc.; in the boulder clay at Caithness; at Elie and Errol; in the Belfast and Larne Lough estuarine clays; and in the Coralline Crag.

This species is found living all round the British coasts.

CLASS GASTEROPODA.

Order CYCLOBRANCHIATA.

Family CHITONIDÆ.

Chiton, Linne.

Chiton sp.

A single plate of a *chiton* sp.? was obtained from the material.

Order PECTINIBRANCHIATA.

Family PATELLIDÆ (PATELLADÆ).

Patella, Lister.

Patella vulgata, Linne.

Patella vulgata, Linn., Syst. Nat., p. 1258.
,, ,, F. and H., vol. ii., p. 421, pl. lxi., figs. 5 and 6.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 236; vol. v., pl. lvii., fig. 1.

Rare. This species appears to be of frequent occurrence in raised beaches and estuarine clays, and is recorded as having been obtained from various places in Scotland.

It is found living on all the rocky coasts of the British Islands.

Helcion, De Montfort.

Helcion pellucidum (Linne).

Patella pellucida, Linn., Syst. Nat., p. 1260.
,, ,, F. and H., vol. ii., p. 429, pl. lxi., figs. 3 and 4.
Helcion pellucidum, Jeff., *loc. cit.*, vol. iii., p. 242; vol. v., pl. lviii., fig. 1.

Frequent. As a fossil this species has been found at Largo, Banff, the Clyde beds at Garvel Park, near Greenock, and at other places in Scotland; it has also been obtained in Ireland.

As a living species it is of frequent occurrence all round our coasts, and is usually found on the fronds of *Laminariæ.*

Tectura, Cuvier.

Tectura virginea (Muller).

Patella virginea, Muller, Prodr. Zool. Dan., p. 237.
Acmæa virginea, F. and H., vol. ii., p. 437, pl. lxi., figs. 1 and 2.
Tectura virginea, Jeff., *loc. cit.*, vol. iii., p. 248; vol. v., pl. lxiii., fig. 4.

Rare. This species as a fossil appears to be generally distributed; in its living state it is equally common.

Family TROCHIDÆ.

Trochus cinerarius, Linne.

Trochus, Rondebetiu

Trochus cinerarius, Linn., Syst. Nat., p. 1229.
,, ,, F. and H., vol. ii., p. 516, pl. lxv., figs. 1-3.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 309; vol. v., pl. lxii., fig. 3.

Common. As a fossil this species is frequently found in the Post-Tertiary deposits throughout these islands, and as a living species it is abundant everywhere on stones and seaweed at low-water mark.

Trochus umbilicatus (Montagu).

Natica umbilicatus, Mont., Test. Brit., p. 286.
Trochus umbilicalis, F. and H., vol. ii., p. 519, pl. lxvi., figs. 1-4.
Trochus umbilicatus, Jeff., *loc. cit.*, vol. iii., p. 312; vol. v., pl. lxii., fig. 4.

Frequent. This species has been recorded from the estuarine clays at Larne Lough, and from the marine accumulations at Portrush, County Antrim.

As a living species it is not so widely distributed as the last.

Family LITTORINIDÆ.

Lacuna divaricata (Fabricius).

Lacuna, Turton.

Trochus divaricatus, Fabr., Faun. Grœnl., p. 392, figs. 7 and 8, pl. lxxxvi., figs. 6-8.
Lacuna vincta, F. and H., vol. iii., p. 62, pl. lxxii., figs. 10-12; pl. lxxiv.
Lacuna divaricata, Jeff., *loc. cit.*, vol. iii., p. 346; vol. v., pl. lxiv., fig. 3.

Rare. As a fossil this species appears to be generally distributed in Scotland, being recorded from Largo and several places on the Clyde, as well as from Aberdeen and Fort William. It has also been obtained in the Belfast and Larne Lough estuarine deposits in Ireland, from the Norwich or Mammalian Crag in England, and from the Continent.

Lacuna puteolus (Turton).

Turbo puteolus, Turt., Conch. Dict., p. 193, figs. 90 and 91.
Lacuna puteolus, F. and H., vol. iii., p. 58, pl. lxxii., figs. 7-9, pl. lxxiv., fig. 9.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 348; vol. v., pl. lxiv., fig. 4.

Frequent. This species has been recorded as fossil from Fort William; from the Clyde beds at Dalmuir, Paisley, Garvel Park; from the estuarine clays at Larne Lough; and from the marine accumulations at Portrush.

Lacuna pallidula (Da Costa).

Nerita pallidula, Da Costa, Brit. Conch., p. 51, t. iv., figs. 4 and 5.
Lacuna pallidula, F. and H., vol. iii., p 56, pl. lxii., figs. 1-4.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 351; vol. v., pl. lxiv., fig. 5.

Rare. In its fossil state this species does not appear to be so widely distributed as the last. It is recorded from Largo; the Clyde beds at Dalmuir and Loch Gilp; from the Larne Lough and Belfast estuarine clays; and from the accumulations at Portrush, County Antrim.

As living species these three appear to be generally distributed around our coasts.

Littorina obtusata (Linne).

Turbo obtusatus, Linn., Syst. Nat., p. 1232, pl. lxxxvi., figs. 2 and 3.
Littorina litoralis, F. and H., vol. iii., p. 45, pl. lxxiv., figs. 3-7, and p. 49.
,, *obtusata*, Jeff., *loc. cit.*, vol. iii., p. 356; vol. v., pl. lxv., fig. 1.

Common.

Littorina rudis (Maton).

Turbo rudis, Maton, Nat. Hist. and Antiq. West Count., vol. i., p. 277.
Littorina rudis, F. and H., vol. iii., p. 32, pl. lxxxiii., figs. 1-7; pl. lxxxiv., fig. 1.
,, ,, Jeff., *loc. cit.*, vol. iii., p. 364; vol. v., pl. lxv., fig. 3.

Common. These two species appear to be widely distributed in the Post-Tertiary deposits of Scotland, and have

also been recorded from the estuarine clays at Belfast and Larne Lough.

In the living or recent state they are common all round these islands.

Rissoa costata (Adams).

Rissoa, Fremin'

Turbo costatus, Adams, in Trans. Linn. Soc., vol. iii., p. 65, t. 13. figs. 13 and 14.
Rissoa costata, F. and H., vol. iii., p. 92, pl. lxxviii., figs. 6 and 7.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 22; vol. v., pl. lxvii., fig. 2.

Rare.

Rissoa parva (Da Costa).

Turbo parvus, Da Costa, Brit. Conch., p. 104.
Rissoa parva, F. and H., vol. iii., p. 98, pl. lxxvi., figs. 2-6; pl. lxxvii., figs. 6, 7; pl. lxxxii., figs. 1-4.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 23; vol. v., pl. lxvii., fig. 3.

Common.

Rissoa membranacea (Adams).

Turbo membranaceus, Adams, in Trans. Linn. Soc., vol. v., p. 2, t. 1, figs. 12 and 13.
Rissoa labiosa, F. and H., vol. iii., p. 109, pl. lxxvi., fig. 5; pl. lxxvii., figs. 1-3; pl. lxxxi., fig. 3.
,, *membranacea*, Jeff., *loc. cit.*, vol. iv., p. 30; vol. v., pl. lxvii., fig. 8.

Frequent.

Rissoa violacea, Desmarets.

Rissoa violacea, Desm., in Bull. Sc. Soc. Phil. Paris, p. 8, pl. i., fig. 7.
,, *rufilabrum*, F. and H., vol. iii., p. 106, pl. lxxvii., figs. 8 and 9.
,, *violacea*, Jeff., *loc. cit.*, vol. iv., p. 33; vol. v., pl. lxvii., fig. 9.

Rare.

Rissoa striata (Adams).

Turbo striatus, Adams, in Trans. Linn. Soc., vol. iii., p. 66, t. 13, figs. 25 and 26.
Rissoa striata, F. and H., vol. iii., p. 94, pl. lxxviii., figs. 8 and 9.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 37; vol. v., pl. lxviii., fig. 2.

Common.

Rissoa semistriata (Montagu).

Turbo semistriatus, Mont., Test. Brit. Suppl., p. 136.
Rissoa semistriata, F. and H., vol. iii., p. 117, pl. lxxx., figs. 4-7.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 46; vol. v., pl. lxxviii., fig. 8.

Not common. With the exception of *Rissoa semistriata*, all the *Rissoæ* here tabulated have been recorded from the Clyde beds. Among the *Rissoæ* recorded by Mr Alfred Bell in his paper "On the Marine Accumulations at Cocklemill Burn in Largo Bay, Fifeshire,"[1] as far as we can make out *Rissoa striata* and *Rissoa parva* are the only species that have representatives in the Fillyside raised beach.

All these *Rissoæ* are found living on the coasts of these islands.

drobia,
rtmann.

Hydrobia ulvæ (Pennant).

Turbo ulvæ, Penn., Brit. Zool., vol. iv., p. 132, t. lxxxvi., fig. 120.
Rissoa ulvæ, F. and H., vol. iii., p. 141, pl. lxxxi., figs. 4, 5, 8, 9; pl. lxxxvii., figs. 2-8.
Hydrobia ulvæ, Jeff., *loc. cit.*, vol. iv., p. 52; vol. v., pl. lxix., fig. 1.

Rare. This species has been recorded as fossil from Largo; the Clyde beds at Dalmuir and Paisley; from the estuarine clays of Belfast and Strangford Lough; and from the Norwich and Coralline Crags.

Hydrobia ulvæ is found living in all the tidal rivers, bays, and inlets, covering the mud flats and oozy sand in countless numbers.

Family Skeneidæ (Skeneadæ).

nea,
ming.

Skenea planorbis (Fabricius).

Turbo planorbis, Fabr., Faun. Grœnl., p. 394.
Skenea planorbis, F. and H., vol. iii., p. 156, pl. lxxiv., figs. 1-3.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 65; vol. v., pl. lxx., fig. 1.

Frequent. As a fossil this species has been found at Largo, and in most of the Post-Tertiary beds of the west coast.

[1] Proc. Roy. Phys. Soc., vol. x., part ii., p. 290.

In its living state it is found between tide marks all round the coast of the British Islands.

Family PYRAMIDELLIDÆ.

Odostomia unidentata (Montagu).

Odostomia, Fleming.

Turbo unidentatus, Mont., Test. Brit. (ii.), p. 324.
Odostomia unidentata, F. and H., vol. iii., p. 264, pl. xcv., figs. 7 and 8.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 134; vol. v., pl. lxxiv., fig. 1.

Frequent. This species is recorded as fossil from the Clyde beds at Loch Gilp, Garvel Park, near Greenock, and from Kilchattan, Bute; also from the Belfast estuarine clays.

Odostomia spiralis (Montagu).

Turbo spiralis, Mont., Test. Brit. (ii.), p. 323, t. 12, fig. 9.
Odostomia spiralis, F. and H., vol. iii., p. 299, pl. xcvii., fig. 2.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 154; vol. v., pl. lxxv., fig. 3.

Frequent. *O. spiralis* has been obtained as fossil at Largo, and from the Clyde beds at Loch Gilp, Dalmuir, and Garvel Park.

Odostomia scalaris (Philippi).

Melania (afterwards *Chemnitzia*) *scalaris*, Phil., Moll. Sic., vol. i., p. 157, t. ix., fig. 9.
Chemnitzia scalaris, F. and H., vol. iii., p. 251, pl. xciv., fig. 5.
Odostomia scalaris, Jeff., *loc. cit.*, vol. iv., p. 160; vol. v., pl. lxxv., fig. 7.

Rare. Two specimens only of this pretty *Odostomia* were obtained in the material from Fillyside.

As a fossil this appears to be a rare species, and does not appear to have been previously recorded for Scotland.

All the *Odostomia* here recorded are found living, and generally distributed throughout the British Islands.

Family Naticidæ.

Natica alderi, Forbes.

Natica alderi, Forb., Mal. Mon., p. 31, pl. ii., figs. 6 and 7.
,, *nitida*, F. and H., vol. iii., p. 330, pl. c., figs. 2-4; and (animal) pl. PP., fig. 5 as *N. alderi*.
,, *alderi*, Jeff., *loc. cit.*, vol. iv., p. 224; vol. v., pl. lxxviii., fig. 5.

Rare. This species appears to be of frequent occurrence in the raised beaches around our coasts.

As a living species it is found everywhere from the extreme verge of low-water mark to the greatest depth within the line of soundings.

Family Solariidæ.

Adeorbis subcarinatus (Montagu). Pl. VIII., figs. 1-3.

1803. *Helix subcarinata*, Mont., Test. Brit., p. 438, t. 7, fig. 9.
1814. ,, ,, Turton, Brit. Fauna, p. 187.
1817. *Trochus rugosus*, Brown, Wernerian Mem., ii., p. 520, pl. xxiv., fig. 5.
1845. ,, *subcarinatus*, Brown, Rec. Conch. of Gt. Brit. and Ireland, 2nd edit., p. 18, pl. xi., figs. 30, 31.
1853. *Adeorbis subcarinatus*, F. and H., vol. ii., p. 541, pl. lxviii., figs. 6-8.
1869. ,, ,, Jeff., *loc. cit.*, vol. iv., p. 231; vol. v., pl. lxxix., fig. 1.

Rare. One specimen only of this well-marked species was obtained in the material from Fillyside, collected by Mr James Bennie in 1869, and, as far as we know, this is the first record of its occurrence in Scotland as a fossil. Searles Wood records it from the Red and Coralline Crag; it has also been recorded from the Belgian Tertiaries, and from one or two other places on the Continent.

As a living species *Adeorbis subcarinatus* is by no means rare, and has been obtained in several places on the coasts of England and Ireland. In Scotland it has been taken in Lamlash Bay, Arran, and on the coast of Aberdeenshire. It is recorded from various localities on the south and south-western coasts of Europe.

Family BUCCINIDÆ.

Purpura lapillus (Linne). **Purpura,** Bruguière

Buccinum lapillus, Linn., Syst. Nat., 1202.
Purpura lapillus, F. and H., vol. iii., p. 380, pl. cii., figs. 1-3.
" " Jeff., *loc. cit.*, vol. iv., p. 276; vol. v., pl. lxxxii., fig. 1.

Rather rare. This is a species which appears to occur as fossil in the Red Crag and every subsequent deposit, including Moel Tryfaen, but is by no means common except in raised beaches.

As a living species it is common everywhere.

Family MURICIDÆ.

Murex erinaceus, Linne. **Murex,** Linne.

Murex erinaceus, Linn., Syst. Nat., p. 1216.
" " F. and H., vol. iii., p. 370, pl. cii., fig. 4.
" " Jeff., *loc. cit.*, vol. iv., p. 306; vol. v., pl. lxxxiv., fig. 1.

Rare. As a fossil this species appears to have as wide a range in geological times as the last, having been obtained in the Quaternary deposit at Strethill, Kelsey Hill, etc., and in the Clyde bed, as well as on the Continent, in the Italian Tertiaries.

In its living condition, this species is found on the southern and western coasts of England and Scotland; off the coasts of Northumberland and Durham, and in Berwick Bay, etc.

Family NASSIDÆ.

Nassa reticulata (Linne). **Nassa,** Lamarck.

Buccinum reticulatum, Linn., Syst. Nat., p. 1204.
Nassa reticulata, F. and H., vol. iii., p. 388, pl. cviii., figs. 1 and 2.
" " Jeff., *loc. cit.*, vol. iv., p. 346; vol. v., pl. lxxxvii., fig. 3.

Rare.

Nassa incrassata (Ström.).

Buccinum (*Incrassatum*), Strom., in Kong. Norsk. vid. Selsk. Skr., iv., p. 369, t. xvi., fig. 25.
Nassa incrassata, F. and H., vol. iii., p. 391, pl. cviii., figs. 3 and 4.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 354; vol. v., pl. lxxxviii., fig. 1.

Rare. These two species have been obtained in the Quaternary deposits, and appear to have a wide distribution.

In the living condition these species are of frequent occurrence throughout the British Islands.

Family PLEUROTOMATIDÆ.

rotoma, arck.

Pleurotoma nebula (Montagu).

Murex nebula, Mont., Test. Brit. (i.), p. 267, t. 15, fig. 6.
Mangelia nebula, F. and H., vol. iii., p. 476, pl. cxiv., fig. 7.
Pleurotoma nebula, Jeff., *loc. cit.*, vol. iv., p. 384; vol v., pl. xci., fig. 1.

Rather rare. The fossil distribution of this species appears to be rather limited; in Scotland, at anyrate, the only previous record is Caithness.

Pleurotoma septangularis (Montagu).

Murex septangularis, Mont., Test. Brit. (i.), p. 260, t. 9, fig. 5.
Mangelia (*Bela*) *septangularis*, F. and H., vol. iii., p. 458, pl. cxii., figs. 6 and 7.
Pleurotoma septangularis, Jeff., *loc. cit.*, vol. iv., p. 390; vol. v., pl. xci., fig. 5.

Rare. This species has been obtained at Cocklemill Burn; Elie; and is also recorded from the estuarine deposit at Belfast.

In the living condition these two species appear to be generally distributed throughout the British Islands.

Order PLEUROBRANCHIATA.

Family BULLIDÆ.

Utriculus truncatulus (Bruguière).

Bulla truncatula, Brug., in Enc. Méth (vers.), t. vi., p. 377, No. 10.
Cylichna truncata, F. and H., vol. iii., p. 510, pl. cxiv.B., figs. 7 and 8.
Utriculus truncatulus, Jeff., *loc. cit.*, vol. iv., p. 421; vol. v., pl. xciv., fig. 2.

Rare. As a fossil this species has been obtained at Cocklemill Burn; in the Clyde beds at Duntroon, and at Garvel Park, Greenock.

Utriculus hyalinus (Turton).

Bulla hyalina, Turt., in Mag. N. H., vii., p. 353.
Amphisphyra hyalina, F. and H., vol. iii., p. 521, pl. cxiv.D., figs. 1 and 2.
Utriculus hyalinus, Jeff., *loc. cit.*, vol. iv., p. 427; vol. v., pl. xciv., fig. 7.

Rare. This species appears to have a much wider distribution than the last, and is recorded from the following Clyde beds:—Dalmuir, Paisley, Garvel Park, Kilchattan, etc.; and from the estuarine clays at Belfast and Larne Lough in Ireland; as well as on the Continent.

These two species are found living in the Laminarian zone on various parts of the British coasts.

Philine nitida, Jeffreys.

Philine nitida, Jeff., *loc. cit.*, vol. iv., p. 456; vol. v., pl. xcvi., fig. 7.

Rare. This appears to be a rare species.

Philine aperta (Linne).

Bulla aperta, Linn., Syst. Nat., p. 1183.
Philine aperta, F. and H., vol. iii., p. 539, pl. cxiv.E., fig. 1.
,, ,, Jeff., *loc. cit.*, vol. iv., p. 457; vol. v., pl. xcvi., fig. 8.

Rare. As a fossil this also appears to be a rare species.

XIV. *On Two of Lindley and Hutton's Type Specimens*—I. Rhacopteris dubia, *L. and H. sp.*; II. Sphenopteris polyphylla, *L. and H.* By ROBERT KIDSTON, F.R.S.E., F.G.S. [Plate IX.]

(Read 20th April 1892.)

Of neither of the above-mentioned species are the original figures very accurate, and with a view of removing this difficulty for their future identification, they are re-figured in the present communication.

With the exception of the types, I have never seen any specimens that could be referred to either *Rhacopteris dubia*, L. and H. sp., or to *Sphenopteris polyphylla*, L. and H., the original specimens of which are in the collection of the Geological Society, London, to whom I am indebted for the privilege of re-figuring and describing them.

I. RHACOPTERIS DUBIA, L. and H. sp.

[Plate IX., Figs. 1 and 1*a*.]

Otopteris? dubia, **L. and H., Fossil Flora, vol. ii., pl. cl., 1835.**
Cyclopteris Murchisoni, **Unger, Genera et Species, p. 98, 1850.**

The fossil is preserved in a fine-grained buff-coloured sandstone, and its preservation is not so perfect as one would have wished.

Among other points mentioned in the description of the specimen by the authors of the "Fossil Flora," they say, on p. 191, after having compared the plant to *Otopteris*, "there would be no doubt indeed of the matter, if the embedded leaflets were all decidedly upon the same plane, for then we should be sure that it was really a pinnate leaf; but the leaflets are so irregularly embedded in the sandstone, some being visible upon fractures of the surface considerably lower than others, that we cannot avoid entertaining a suspicion that the leaflets, or rather leaves, as in that case they would be, were either whorled or placed all round a slender stem. Should this be so, the plant would then be a new species of either *Spenophyllum* or

Trizygia, both of which are genera confined to the Coal-Measures; and this is perhaps the more probable supposition."

"As far as we can make out, the ends of the leaflets were rounded as we have represented them, but we cannot be sure that the margin has not been broken away."

Although probably it would have been wiser not to have founded a new species on this specimen, still in some respects the state of preservation of the fossil is not so imperfect as the above quotation would lead one to believe.

On Plate IX., Fig. 1, is given a carefully prepared illustration of the plant. The rachis is thin but of firm texture, and well shown; towards the upper part of the specimen it is broken, and the separated part is slightly displaced to the left. The leaves on the right are on a lower level than those on the left, owing to the oblique manner in which the plant has been embedded in the stone, as described by the authors of the "Fossil Flora," but the position of the rachis clearly shows that all the pinnules were originally placed on the same plane. The plant is without doubt a *Rhacopteris*.

Only two of the pinnules appear to show their apex—the sixth and seventh from the top on the right side. Their ground tissue has almost entirely disappeared, hence the terminations of the veins are all that is left to mark the circumference of the pinnules.

Fig. 1*a* shows the nervation, and what has *probably* been the form of the pinnules.

The specimen, which is from the (? Middle) Coal-Measures, Knowlsbury, Shropshire, was communicated to Lindley and Hutton by Sir Roderick Murchison.

II. Sphenopteris polyphylla, L. and H.

[Plate IX., Figs. 2, 2*a*, 2*b*, 2*c*.]

Sphenopteris polyphylla, L. and H., Fossil Flora, vol. ii., pl. cxlvii., 1835.

Description.—Frond bipinnate (or decompound ?); pinnæ alternate; uppermost ultimate pinnæ reduced to an oval or oval-lanceolate blunt pinnule; lower ultimate pinnæ deltoid,

and bearing about five pinnules. Pinnules obtuse, oval, obovate, or cyclopteriod-orbicular; terminal pinnule oval or oval-rhomboidal, obtuse; notched or lobed, the lobes being, in some cases, deeply cut and almost separated from the terminal pinnule. Veins distinct, generally only once divided and placed in furrows—a central vein scarcely present, the veins generally radiating from the short foot-stalk of the pinnules.

Remarks.—At Fig. 2*c* is shown one of the ultimate pinnæ from near the apex of a (?) primary pinna. It consists of an obovate terminal pinnule and two lateral lobes. In fact, the whole structure may be regarded as a single pinnule with a terminal and two basal lobes. Figs. 2*a* and 2*b* show portions of two pinnæ from the base of a (?) primary pinna —2*a* being almost complete; 2*b* only showing its lower portion. In 2*a* only the two lowest pinnules are free and stalked, the angle pinnule being lobed, one of whose lobes is almost completely separated.

This species forms one of a group, to which Schimper has applied the term *Sphenopteris-Aneimiites*.[1] The group contains a number of closely-allied species, of which may be mentioned *Sphenopteris obtusiloba*, Brongt, *Sphen. trifoliolata*, Artis sp., *Sphen. nummularia*, Gutbier, and *Sphen. Sauveurii*, Crépin.

Sphenopteris polyphylla, L. and H., is smaller in all its parts than *Spen. obtusiloba*. The terminal lobe is also much larger in *Sphen. polyphylla* in proportion to the other pinnules, and its ultimate lower pinnæ are more deltoid in outline. From *Sphen. trifoliolata* it is easily separated by the form of the pinnules. The growth of the two species has also a different aspect, and in *Sphen. trifoliolata* the terminal pinnules are small. The same remarks distinguish *Sphen. Sauveurii* from *Sphen. polyphylla*, though there are also other points of difference. *Sphen. nummularia* is easily separated from *Sphen. polyphylla* by its lanceolate pinnæ, with small terminal lobe and close-set and only slightly lobed pinnules.

[1] Schimper, Traité d. paléont. végét., vol. i., p. 399, 1869. Also see Zittel, Handbuch d. palænt., Abth. ii., Palæophytologie, p. 108, 1879.

The type of *Sphen. polyphylla*, which was collected by Mr Lewis, came from the (? Middle) Coal-Measures, Titterstone-Clee Hills, Shropshire, and was communicated to Lindley and Hutton by Sir Roderick Murchison.

Explanation of Plate.

Fig. 1. *Rhacopteris dubia*, L. and H. sp.; from Knowlsbury, Shropshire; natural size. The original specimen figured by Lindley and Hutton.

Fig. 1*a*. Pinule enlarged two times to show nervation.

Fig. 2. *Sphenopteris polyphylla*, L. and H.; from Titterstone-Clee Hills, Shropshire; natural size. The original specimen figured by Lindley and Hutton.

Figs. 2*a*, 2*b*, 2*c*. Portions magnified two times to show nervation and pinnule cutting.

XV. *On a New Species of* Bythotrephis *from the Lower Carboniferous of Lancashire.* By Robert Kidston, F.R.S.E., F.G.S. [Plate X., Figs. 1-3.]

(Read 20th April 1892.)

In dealing with fossil Algæ, great care is necessary, as many inorganic markings and tracks of animals assume very plant-like forms, and several of these casts have in past time been, in error, described as Algæ.

The specimens which I now describe are, however, of undoubted vegetable origin. The fossils are preserved in a very friable soft light-grey-coloured shale, composed of very thin lamina, which have a great tendency to scale off. The fossils themselves are of a rich brown colour, owing to the delicate carbonaceous film having been impregnated with iron. A small portion of this film was removed, and on examination under the microscope was seen to be composed of narrow elongated tubular cells.

Of the eight specimens collected, the two best are shown on Plate X., Figs. 1 and 3, and at Fig. 2 is shown a small example that occurs on the back of the slab which contains that given at Fig. 1.

Fig. 3 gives the best idea of the general character of the

fossil. From a basal stalk-like portion several branches are given off (which probably originate through dichotomy of the stalk-like pedicel). These branches, by repeated dichotomy, form a frondose expansion, consisting of a series of equal dichotomies.

Fig. 1 shows the upper part of a similar specimen, where the same characteristic dichotomy of the branches is well exhibited. Neither of these specimens gives in any case a well-preserved termination of the branchlets, but this point is well illustrated by the small specimen given at Fig. 2, and the termination of the branches is represented enlarged at Fig. 2*a*. Their apices are blunt and slightly swollen.

There is no data from which the affinities of these fossils can be discussed. The species has been named from the locality at which it was discovered.

My thanks are due to Sir Archibald Geikie for kindly giving me the opportunity of figuring and describing the specimens.

The fossils were collected by Mr James Rhodes, one of the Fossil Collectors to the Geological Survey of England, and are in the Geological Survey Collection, Museum of Practical Geology, Jermyn Street, London.

Locality.—Worston Beck, near Clitheroe, about a quarter of a mile above Hall Foot House, Lancashire.

Horizon. — Shales under Pendleside Limestone, Carboniferous Limestone Series of England (= Calciferous Sandstone Series of Scotland).

EXPLANATION OF PLATE.

Figs. 1-3. *Bythotrephis Worstonensis*, Kidston; natural size.

Fig. 2*a*. Small portion enlarged to show the terminations of the branchlets.

Registration numbers of specimens in the Geological Collection,—Fig. 1, No. Rh. 975; Fig. 2, Rh. 975; Fig. 3, Rh. 979.

XVI. *On the Moulting of the Diurnal Birds of Prey.* By J. G. Goodchild, F.Z.S., M.B.O.U.

(Read 20th April 1892.)

[Abstract.]

The writer aimed at showing that, in captivity, three types of change of plumage may be observed in the birds of prey, and he argued that to a certain extent this may prove to be true also in regard to their moult in a state of nature. In the first of these the bird moults several years in succession into much the same style of plumage as that of its first year's dress. This is the case with some species of *Aquila* and of *Haliaetus* in captivity, and it was particularly noticeable in a female Condor living for several years at the London Zoological Gardens; each year's moult gave rise to a new dress, differing little, if at all, from that of the first year. The writer made water-colour drawings of this bird for Mr Gurney and others, with a view to recording any change that might arise. At last a few lead-grey feathers began to appear amongst the older brown, and the bird's iris showed evident indication of a change to the garnet colour characteristic of that part in the adult; but the change had only just commenced when the bird died. Mr Gurney regarded this as a case of deferred maturity; but was uncertain whether the bird, in a state of nature, would have moulted more than two or three years before assuming the adult dress.

In the genus *Spizaetus*, a change of a different nature may be observed. In these the approach to the fully adult plumage is made by successive changes extending over at least four moults, each dress being more like the adult than that which preceded it. In strikingly coloured species, like *Sp. ornatus* or *Sp. coronatus*, this successive change of plumage can hardly fail to attract attention. That in a state of nature the adult plumage of the Spizaeti is reached by successive steps is clearly proved by an examination of any large series of skins. *Geranoaetus* appears also to follow the same rule as *Spizaetus* in this respect.

A third type of moult, and the most prevalent, is that

in which the adult plumage is assumed at the first change of dress. The change commences about nine months after birth, and extends over the two or three months following. This is the rule with all the Hawks and Falcons, and is probably true of a large number of the Buzzards, Kites, and Harriers. In the Hawks and Falcons substantially no change of colour takes place after the first moult; if the individual is dark in colour to begin with, it moults into a dark style of adult dress; if it is light when young, so it moults; and it is more than doubtful, in the case of these birds, whether any further change takes place until the bird passes its prime, and even then the change appears to affect the females only. It is quite a mistake to assume, for example, that a pale blue Peregrine is necessarily a very old bird, or that a dark plumaged one is comparatively young. The dark colour, or the light, is an individual characteristic, and quite independent of age.

Seasonal changes of plumage, like those seen in the Dunlin, or in the Mallard, do not appear to have been noted amongst any birds of prey. Nor is there any such change of aspect as that produced in the Starling, the Lapwing, or the Linnet, by the weathering away of the feather ends, and the consequent exposure of a brightly coloured inner part.

XVII. *Notes on Carboniferous Lamellibranchs.* By J. G. Goodchild, F.G.S., F.Z.S., H.M. Geol. Survey.

(Read 17th February 1892.)

Ctenodonta and *Nucula.* Mr Robert Etheridge, jun., showed some years ago that the nuculoid Lamellibranchs occurring in rocks of later Palæozoic age possess a distinct cartilage pit, and could not, therefore, be properly referred to Salter's genus *Ctenodonta.* This observation has received abundant confirmation since. But Mr Etheridge considered that such beaked forms as *Nucula attenuata*, Ph., and its allies belonged to a different genus, which has been usually referred to *Leda*, mainly on account of its form, and of late years to *Nuculana* for the same reason.

The characters afforded by several well-preserved interiors of *N. attenuata* showed, however, that there is no trace whatever of any pallial sinus, and that in other respects, except the posterior attenuation of the shell, it does not differ from the recent *Nucula.* It is therefore proposed to return to the older name and to group *N. attenuata, N. sharmani, N. traquairi,* and other allied forms with *Nucula,* of which, at the most, they form but a subgenus. *N. intermedia,* and *N. brevirostrum,* Port., connect this subsection with the type forms.

Dr Traquair has kindly lent several specimens of this genus for examination.

It will be interesting to note, in tracing the history of these shells back in time, on what precise geological horizon the cartilage pit which distinguishes *Nucula* from *Ctenodonta* begins to appear; and, in continuing their history into Neozoic times, when the pallial sinus assumes a definite form.

XVIII. *Note on the genus* Allorisma, *King.* By J. G. GOODCHILD, H.M. Geol. Survey, F.G.S., F.Z.S.

(Read 20th January 1892.)

[ABSTRACT.]

An examination of a large number of Carboniferous Lamellibranchs, variously referred to *Myacites, Sanguinolites,* and some other genera, confirms the view expressed by Professor King that these are referable mainly to the two genera *Edmondia* and *Allorisma.* The author had examined a sufficient number of internal casts of various species of *Allorisma* to feel justified in proposing an extended description of the genus, which is given as follows:—Genus *Allorisma* (Grammysiidæ). Shell equivalved, very inequilateral, umbones approximate, subterminal; extremities gaping; hinge line nearly straight, occupying at least four-fifths of the entire length of the shell; ligament external, no internal cartilage; shell thin, strengthened by corrugations running parallel to the edges, and also by slight radial

thickenings extending from the umbones backwards to the infero-posterior margin. Close beneath the hinge there is a well-marked strengthening rib, which ranges backward from the umbo, and is subparallel to the dorsal margin of the shell. In some species the thickness of this rib is more than double that of any other part of the shell. Adductor impressions subequal in size, the anterior impression situated close to the edge of the shell, and bounded by a slight ridge. Posterior adductor somewhat larger, but less strongly marked, situated far forward, and close beneath the hinge.

The pallial sinus has been clearly made out in many specimens belonging to at least six species of *Allorisma*. In *A. clava* it extends to a point about midway between the umbo and the posterior margin.

Sanguinolites striato lamellosus, De Kon., *S. glabrata*, Phillips, and *S. tricostata*, Portlock, belong to the Carditidæ, and have only a remote relationship with the present genus.

The author is indebted to Dr Traquair for the loan of specimens.

XIX. *Note on* Falco sacer. By J. G. Goodchild, F.Z.S., M.B.O.U.

(Read 20th January 1892.)

[Abstract.]

The Saker still appears to be one of the falcons about which comparatively little is yet known, as nearly all the descriptions of it that have yet been published fail to give its specific diagnosis in full. The late Mr John Henry Gurney pointed out to the writer some years ago that in all stages of plumage this species could be readily distinguished from any of the allied forms by the character of the markings on the tail feathers, which in *F. sacer* invariably take the form of elliptical spots of cream-colour on each web, and never that of continuous bars. To this the writer would add, the colour of the legs and feet, which are greenish-blue in the adult state—in which respect they stand quite alone amongst the

falcons. The central tail feathers also are somewhat longer in proportion to those adjoining, and are more pointed than in ordinary.

There is a common belief that the Saker tends to assume a barred plumage like the Kestrel as the bird advances in years; in this state it has been sometimes regarded as a distinct species, and named *F. hendersoni.* The present writer regards this phase of plumage as due, not to age, nor to individual variation, but to the effect of captivity upon the plumage. When not exposed to the bleaching action of the tropical sun, the contour feathers of the Saker retain the dark brown bars which characterise the newly-moulted condition, while in a wild state the whole feather bleaches down to a nearly uniform earthy grey. Sakers moulted in captivity are always more or less barred, while hardly any wild bird shows more than the faintest trace of such markings.

XX. *A Method of Injecting the Canal of Petit.* By James Musgrove, M.D., Demonstrator of Anatomy, Edinburgh University.

(Read 16th December 1891.)

I wish to describe a method of injecting the Canal of Petit in the eye, which, for demonstration purposes, presents certain advantages over the methods usually employed for displaying this lymphatic space. Hitherto, it has been customary to show the canal either by making an antero-posterior section of the eyeball, or by inflating the canal with air, after its removal from the eye along with the lens and vitreous. The first method gives a very imperfect idea of the size and shape of the canal, and the method of inflating with air has the great disadvantage that the specimen cannot be preserved for any length of time. It therefore occurred to me to try another plan, or rather, to modify the second method, by injecting the canal with liquefied carmine-gelatine, which is solid at ordinary temperatures. The Canal

of Petit stands out as a red ring around the margin of the lens.

The specimen is prepared in the following manner:—The muscles and fat surrounding the eye of an ox are removed, and an incision made along the equator of the eye-ball, so as to divide the sclerotic into two parts, one being attached to the optic nerve, and the other to the cornea. The beginning of the cut is made with the knife, so as to allow one blade of the scissors to be inserted between the sclerotic and choroid. The cut is then completed with the scissors, great care being taken that the vitreous is not punctured. The next stage consists in turning the two parts of the sclerotic inside out, so as to allow more room for the division of the choroid. The choroid is divided in a similar manner with the scissors, and the vitreous together with the lens and Canal of Petit allowed to fall out, bursting through the retina. Any pigment from the ciliary processes may be brushed off from the suspensory ligament of the lens with a camel-hair pencil under water. The canal may then be injected with a hypodermic syringe, previously filled with melted carmine-gelatine. The needle of the syringe is pushed through the anterior wall of the canal, more or less horizontally, close to the margin of the lens, and the gelatine forced into the canal. It may flow all the way round the lens, but, as a rule, it is better to inject the canal at twice, withdrawing the needle after the injection has flowed half way round the canal, and re-inserting it where the fluid stopped, so as to inject the remainder. The specimen is best preserved in a mixture of equal parts of glycerine and methylated spirits.

XXI. *The Facts of Sex in Relation to Metabolism: A Review of some recent Theories.* By J. ARTHUR THOMSON and NORMAN WYLD.

(Read 20th April 1892.)

1. OBJECT OF THE PAPER.—The students of nature range themselves into two parties distinguished by their practice. There are some who, whether from carelessness of the results to be gained, or from respect for the complexity of otherwise tempting problems, refrain from the theoretical interpretation of facts, and keep themselves to the collection and arrangement of experiences; and there are others who, undeterred by failures, venture hypothesis after hypothesis until one that fits is found. The history of science is the justification of both. The present paper neither brings new facts nor offers new solutions, but is an estimate and co-ordination of some recent suggestions as to the significance of sex.

2. HISTORICAL NOTE.—Although some knowledge of the facts of sexual reproduction dates from ancient times, no precise analysis of any one of the problems involved was attempted, nor could have been attempted with success, until after embryology had begun to rise on a sure foundation. When we remember that it was only in 1843 that Martin Barry—a student of whom Edinburgh is proud—observed the union of spermatozoon and ovum, we understand how recent all scientific theories of sexual reproduction must be. It is true that Blumenbach in the last century spoke of four hundred theories of sex, and himself ventured a four hundred and first, but these were for the most part confined to speculative suggestions as to what determines whether an embryo will become a male or a female—they were not general theories of sexual reproduction. From various positions, since embryology ceased to be infantile, important steps were made, notably Darwin's theory of Sexual Selection. But even when we take account of all the suggestions offered, *e.g.*, by Owen, Leuckart, Minot, Brooks, Rolph, Simon, Sabatier, Hertwig, and Weismann, and of Hensen's valuable monograph contained in Hermann's *Physiologie*, we must, as it seems to us, admit that the first

general theory was that of Patrick Geddes. This was first sketched in a paper read before the Royal Society of Edinburgh, developed in the articles "Reproduction" and "Sex" in the *Encyclopædia Britannica*, and finally elaborated in the "Evolution of Sex" (London, 1889) by Geddes and Thomson. Since the publication of this work, which, in spite of the imperfections of a pioneer essay, has had the effect of stimulating research and discussion, several criticisms and fresh theories have been advanced. It is with a few of these, and with the general thesis of the "Evolution of Sex," that we have here to do.

3. General Theory of Metabolism.—As a necessary preliminary, we must take account of the modern conception of metabolism.

So evidently is an organism a system adapted for receiving and transforming matter and energy, that the general idea of waste and repair has never been far from the minds of physiologists. One of the first to make this general idea more precise was De Blainville, who described vitality "as a twofold internal movement of composition and decomposition." After a time, Claude Bernard—a pioneer in the physiology of protoplasm—distinguished "disassimilating combustion and assimilating synthesis."

Of recent years various researches and speculations, especially those of Hering and Gaskell, have led physiologists to yet more precise statements in regard to metabolism—in some cases perhaps more precise than the known facts warrant.

Let us carefully notice some of the uncertainties:—

(*a*) We do not know whether protoplasm or *the* living matter is one complex substance or a mixture of substances, nor within what limits its nature may vary in different organisms, in different tissues, or at different times.

(*b*) We do not know whether, as Prof. Michael Foster suggests, the protoplasm of a cell is, as it were, the centre of the metabolic processes, being constantly made and unmade, breaking down into waste products, and being built up from food; or whether it is, as Prof. Burdon Sanderson suggests, a relatively stable stuff, which acts like a ferment on adjacent less complex material, now promoting construction, and again disruption.

(*c*) And, while every one recognises that there are two sets of vital processes—one of assimilation, construction, or synthesis; the other of disassimilation, dissipation, or analysis, when we come to consider these complementary sets of processes (conveniently termed anabolism and katabolism) we find that we do not know whether both are in the same sense activities dependent on stimuli (Hering), or whether anabolism is self-regulative, *i.e.*, autonomic (Gaskell).

(*d*) Moreover, until we can trace in much greater detail than is at present possible whole series of chemical transformations, of which we have at present merely glimpses, we shall not be able to say with security that this or that substance is an anastate or a katastate—a stage in a constructive or in a disruptive process. For it is evident that a substance of some complexity might be either a step in the upward raising of food or a step in the disruption of highly complex material.

In presence of so much uncertainty, it seems wise either to discard altogether such apparently precise terms as anabolism and katabolism, or to use them at present in a very wide sense, as wide as is consistent with utility. Let us illustrate the manner in which the terms may be used.

Nothing is more characteristic of organisms than their power of growth, or their progressive accumulation of matter and energy. Now, when a cell or an organism continues for a time to feed well and to increase in size, remaining also quite healthy, it seems to us almost a truism to say that during this period of growth the processes of construction, of chemical synthesis, of accumulation of matter and energy, have been more rapid, and, on the whole, greater than those of disruption and expenditure.

If we could measure in normal adult life the constructive or anabolic processes by which there is a storage of potential energy, and the disruptive or katabolic processes in which energy is expended, and if we express their relation during assimilation by the ratio $\frac{A}{K}$, this ratio is greater than unity; while during the time that assimilation is not in

progress, but the assimilated matter is being utilised, the ratio is less than unity. During the phase of mature life the ratios vary indeed from hour to hour, but the mean of the various ratios $\frac{A'}{K'}$, $\frac{A''}{K''}$, etc., equals unity, while during the phase of growth the mean of the ratios (which have also periodic variations) is greater than unity.

It must be carefully noticed that there may be for equal periods of time more anabolism in the mature organism than in one that is growing, but in all animals the general ratio $\frac{A}{K}$ will be greater during adolescence than during maturity. Moreover, as the rates of assimilation and dis-assimilation fluctuate greatly at different times, in contrasting different phases, the mean of the ratios for corresponding periods must be considered.

4. Minot's Conclusions as to Growth.—In this connection it is interesting to notice, partly by way of illustration, Prof. C. S. Minot's investigations on growth. With admirable patience he has framed from observations on guinea-pigs the most exhaustive series of statistics on growth which we at present possess. His observations, though chiefly on guinea-pigs, were not restricted to these, and his results are striking. He finds that "the rate of growth of the guinea-pig declines almost from the moment of birth onward, and there is no such thing in the history of the guinea-pig as a distinction between the period of development and the period of decline. It is one steady decline when we measure the actual growth in this proper, exact manner. The same law holds true of man, of chickens, of rabbits, of dogs, of ferrets, of all of which animals I possess sufficient statistics to speak with confidence." There is, he says, a progressive loss in power of growth, "a steady loss of vitality." "Whereas the first ten per cent. of addition is made in a time a little exceeding two days, the twenty-fifth addition of ten per cent. is made in a period of nearly eighty-eight days." Moreover, Minot also finds that as age increases the ratio of protoplasm to nucleus in the cells increases, and so he reaches the somewhat unexpected conclusion that "proto

plasm interferes with growth," and half-humorously defines protoplasm as "the physical basis of advancing decrepitude"!

We do not mean to wander from our subject to the extent of discussing this increased ratio of cytoplasm to nucleoplasm, nor the reason why growth should illustrate the law of diminishing return, but it will be useful to explain why we do not propose to accept Minot's conclusion that from the period of birth there is "a steady loss of vitality." Growth, as we understand it, means that anabolism is greater than katabolism. When growth is rapid the ratio $\frac{A}{K}$ is a large one. As the animal grows older, it becomes more active, and it prepares for reproduction. It is evident that either by increase of katabolism, or by a transference of the results of anabolism from increase in bulk to other ends, *e.g.*, reproductive, the rate of growth may diminish without there being any "loss of vitality." And it is evident that a guinea-pig which has almost ceased to grow may have a more intense metabolism, more anabolism and more katabolism, in short *greater* vitality, than one which has lived only for a few days and is growing rapidly. In the former the ratio $\frac{A}{K}$ will be less than the ratio $\frac{A'}{K'}$ for the latter; but A will be greater than A' and K greater than K', and since vitality must be measured by the *rate* of the transformation of energy per unit mass, it is greater in the former than in the latter.

But, furthermore, we are of opinion that Prof. Minot's facts prove after all very little. For unless (1) the rate the taking in food (involving size of mouth, power of lowering air-pressure in lungs by diaphragm and ribs, etc.) and (2) the rate of assimilation (involving digestive, absorptive, and assimilative processes) were to increase at precisely the same rate as the weight of the young organism increases, it would be impossible for the rate of increase of weight to be constant, and since that rate of increase is destined to $=0$, the fact that the curve representing the rate of growth is a continuously descending one is not in the least surprising.

Surely, too, the conclusion that protoplasm interferes with

growth is an example of a familiar syllogistic fallacy. For from the premises (*a*) that the rate of growth decreases with time, and (*b*) that the ratio of protoplasm to nucleoplasm increases with time, the inference that protoplasm retards growth is obviously illegitimate.

5. Facts of Sex and Sexual Reproduction.—In illustration of what we mean by the facts of sex and sexual reproduction, we may recall the following, some of which, be it carefully noticed, are only "average truths," to which it is easy to find individual exceptions.

(*a*) In cases of incipient sexual dimorphism, which occur among Protozoa and Protophyta (*e.g.*, *Vorticella* and *Volvox*), we have to distinguish a larger, apparently better nourished, more passive macrogamete from a microgamete with opposite characteristics.

(*b*) Among Metazoa, in the majority of cases, reproduction occurs by the liberation of unicellular germs from dimorphic individuals or males and females. The female organisms tend to be more passive, larger, plainer, and of longer life; the male organisms tend to be more active, smaller, more decorative, and of shorter life.

(*c*) Excepting a restricted minority of parthenogenetic organisms, the continuance of life seems to depend on the union of dimorphic sex-cells. The ova or reproductive cells produced by the female tend to be large, passive, rich in stores of potential energy; the sperms, or reproductive cells produced by the male, tend to be minute, active, and with little store of potential energy. These reproductive cells are mutually dependent, and in fertilisation they unite in an intimate and orderly manner.

(*d*) The quantity of reproductive material produced by the female is generally greater than that produced by the male, partly because the female supplies the germ with a capital of nutriment, and partly for other reasons.

(*e*) In the development of ova, embryos, and larvæ, it seems that abundant nutrition and other conditions which favour the accumulation of matter and potential energy, tend to the production of female rather than male offspring.

6. The Thesis of "The Evolution of Sex."—The general

theory maintained in "The Evolution of Sex" may be summed up in the following propositions:—

In the individual life of a plant there is a marked contrast between the growing vegetative phase and the flowering reproductive phase. During growth anabolism is "relatively preponderant," during the reproductive period katabolism is "relatively preponderant." In animals also, reproduction usually occurs at the limit of growth, when anabolism begins to become less preponderant.

All living creatures may be contrasted in terms of their relative activity, as measured by the rate and amount of movement and work which they accomplish, and by the rate and amount of potential energy stored. Thus one may contrast plants and animals, gregarines and infusorians, hydroid and medusoid, reptile and bird, and so on throughout a long series of antitheses between relatively passive and relatively active forms.

Parallel to this is the contrast between the sexes. Whether one considers the relative sizes of the sexes, or their essential reproductive functions, or the reproductive elements which they produce, or the secondary sexual characters, or what is known of their chemical constitution, or the factors which tend to produce male or female offspring, or the first hints of sexual differentiation among the simplest creatures, it seems to the authors of "The Evolution of Sex" that the female is the outcome and expression of relatively preponderant anabolism and the male of relatively preponderant katabolism.

Thus the contrast between the sexes is brought into parallelism with the general contrast between relatively active and relatively passive, more katabolic and more anabolic organisms, and is regarded as one expression of the alternatives of protoplasmic metabolism which may be read throughout the whole organic world.

While in the main accepting, or continuing to accept, the general interpretation suggested in "The Evolution of Sex," it seems to us necessaay to correct an inaccuracy in the statement of the principal theorem—an inaccuracy which has given rise to misunderstandings on the part of more hostile critics. We seek to restate the theorem in more precise terms.

Throughout the work referred to, it is over and over again stated that the female is the outcome and expression of preponderant anabolism, and the male of preponderant katabolism. But it is at once evident that a cell or an organism with preponderant katabolism must very soon die. We, Fellows of this Society, are male organisms, but, as we hope to live, we certainly cannot believe ourselves the victims of preponderant katabolism. This, of course, was not what the authors intended to suggest.

It is rather this—that if in a female organism the amount of anabolism (storage of potential energy) and of katabolism (dissipation of potential energy) be contrasted by the ratio $\frac{A}{K}$, and if in a male organism of the same species the same sum of vital processes be contrasted in a similar ratio $\frac{A'}{K'}$, then the ratio $\frac{A}{K}$ will be greater than the ratio $\frac{A'}{K'}$; greater during growth because the female in the same time grows larger, greater during maturity because the female gives away a larger amount of reproductive material.

In the same way, to take another illustration, it is quite likely that the amount of anabolism for a given period of time is greater in the bird than it is in the tortoise, and it is, we should suppose, certain that the amount of katabolism for the same period is much greater in an active bird than in a sluggish tortoise, but the only satisfactory contrast is between the ratio $\frac{A}{K}$ in either case.

It is this conception of a contrast of ratios which appears to us a necessary correction of the general thesis of "The Evolution of Sex."

7. Ryder's Theory of Sex.—One of the most important recent contributions to the biology of sexual reproduction is to be found in a paper entitled "The Origin of Sex through Cumulative Integration, and the Relation of Sexuality to the Genesis of Species," read in 1890 before the American Philosophical Society by Mr John A. Ryder. In this elaborate paper, which covers fifty pages of small type, there are many brilliant suggestions and speculations, the effect of which we cannot but feel to be somewhat blurred by the

unfortunately complex and involved style, which is at times psychologically dangerous for his readers if not for the author himself.

Mr Ryder lays great emphasis on "cumulative integration," by which he means that "living matter tends to increase beyond the actual physiological requirements of its secular existence." That the power of growth is the essential peculiarity of living organisms has been long recognised by biologists, but no one has brought the fact into relation with the facts of sex in the way that Mr Ryder has done. He finds in it the dynamic peculiarity of organisms which has made multiplication, morphological differentiation, the struggle for existence, and sexuality possible. We do not know, however, that Mr Ryder's cumulative integration means anything more than what other biologists call growth, and though we agree with him as to the fundamental importance of the fact, and admire the manner in which he has treated of it, we are unable to agree with him (unless he means it as a mere prophecy) that "the chemical and physiological laws under which growth or molecular integration can take place are themselves resolvable into physical laws which can be co-ordinated under the principle of the conservation of energy."

For while we must accept the doctrine of the Conservation of Energy as fundamentally true, it remains obscure how we are precisely to interpret, in terms of it, the peculiarity of an organism that it absorbs energy progressively.

This question has recently received very careful treatment at the hands of a competent physicist—Mr J. Joly of Dublin—who, in an interesting paper, entitled "The Abundance of Life," draws the dynamic contrast between an animate and an inanimate system in the following terms:—

"The transfer of energy into any inanimate material system is attended by effects retardative to the transfer, and conducive to dissipation, while

"The transfer of energy into any animate material system is attended by effects conducive to the transfer, and retardative of dissipation."

According to Mr Ryder, "The origin of sex hinges upon the decision of how the disproportion between the chromatin

and the cytoplasm arose in the sexual products of the two sexes respectively."

An ovum is a "large overgrown type of cell, loaded with cytoplasm and its secondary products"; in its production "there occurs a prolonged process of integration of plasma"; the result is "an enormous cytoplasmic field, in the midst of which there is placed a large nuclear body containing, proportionally to its envelope of cytoplasm, a very small amount of chromatin." *In short, in the reproductive cell produced by a female, there is a preponderance of cytoplasm over chromatin.*

A spermatozoon is a very minute type of cell, "consisting mainly of plasma in a highly anabolic condition as chromatin," "characterised by the absence of a cytoplasmic field, in which nuclear motion, or karyokinesis, can occur"; "the elaboration of the chromatin in the male clearly takes place in some cases at the expense of cytoplasm"; "in consequence of the reduction of its cytoplasmic field, it becomes incapable of further independent development"; "in the production of male elements an actual process of elimination of cytoplasm often occurs, so as to reduce the latter to a minimum, and leave little remaining except the nucleus and its chromatin." *In short, in the reproductive cell produced by a male, there is a preponderance of chromatin over cytoplasm.*

[So far an introductory statement of the contrast between the sex-cells, according to Ryder. He makes an important criticism of "The Evolution of Sex," when he says: "The view that the female is preponderatingly 'anabolic,' and the male 'katabolic,' as held by Geddes and Thomson, cannot be sustained on the basis of fact, since it is readily demonstrated that the male element represents a higher product of constructive metabolism than the female."

To this it may be replied:—(1) That the theory of sex proposed in the "Evolution of Sex" does not rest on an interpretation of the reproductive cells alone, but of many other facts; (2) that several statements in the work cited are insufficiently precise, and require to be compared with other parts of the book, and require to be corrected in terms of what we have noticed above; (3) that although we

suppose yolk to be chemically simpler than protoplasm, and although the cytoplasm may run down chemically into yolk, which would therefore be katastatic, the life-equation of an egg-cell is one in which potential energy is accumulated, and one which in its state of maturity has a rich store of reserve material. The male cell, on the contrary, has a very small store of potential energy, and at its maturity is usually highly katabolic.

If we picture an egg-cell incorporating neighbour-cells, as is often the case, and suppose that the additional cytoplasmic material thus acquired sinks down into the more stable and simpler state of yolk, this sinking down may be called katabolic. Its result, however, is that the egg-cells become rich in stores of potential energy. Nor is the process of yolk-forming known with much definiteness. It is possible enough that in some cases the material derived from the blood may be worked up into yolk, which would be a process of constructive metabolism.

When Mr Ryder says that the spermatozoon "consists mainly of plasma in a highly anabolic condition as chromatin, and therefore represents a higher product of constructive metabolism than the female," he is at once illogical and incautious. The chromatin of the sperm must be compared with the chromatin of the ovum, and not with its yolk; we do not know how the chromatin is related to the general protoplasmic metabolism, nor do we know that the chromatin of a male cell is chemically the same as that of a female cell.

When, however, we see a small cell manifesting great activity for a short period, and unable to replace its loss by nutrition, we say that in the life-equation of such a cell the ratio $\frac{A'}{K'}$ is much less than the ratio $\frac{A}{K}$ in a mature ovum. We should not call the sperm an anabolic cell, as Mr Ryder does.

Even Mr Ryder admits that the spermatozoon "has a greater capacity for katabolic change than the female, as measured by the relative volume of its nucleoplasm, but absolutely it has far less, because of its small size, as compared with the whole ovum." But, as we have already

stated, the only contrast which we believe to be sound is a relative one, which contrasts the ratio $\frac{A}{K}$ in either case.]

Having taken, as the essential distinction between the egg and the spermatozoon, "that the cytoplasm preponderates in the one, while the nucleoplasm preponderates in the other," Mr Ryder continues his argument as follows:—

"There was a time when asexual reproduction, through fission without karyokinesis, was effected by forms which were morphologically male." By "morphologically male"—a somewhat question-begging and unfortunate phrase—the author means that the primitive cells were flagellate cells, "poorly provided with cytoplasm, with preponderant chromatin." "The really primordial type of the germs of all living forms is a flagellate cell, and not an ovum." Sometimes he compares them to bacteria, "with lack of differentiation into nuclear and cytoplasmic matter." "The male state also, as represented in the spermatic body, tends to revert to the most ancient form of all free mobile organisms, namely, the flagellate Schizomycetes." "In the lowest living forms, chromatin presumably preponderates;" or again, "their substance is mainly chromatin-like."

From all this he draws the conclusion that "maleness," or the condition of the flagellate spore, is the primitive one. "The male state is therefore the primitive one, and in the prodigious fertility of the male represents the primordial, asexual, flagellate types."

In the course of evolution, however, as the result of "cumulative integration," an increase of cytoplasm came about, "which proceeded so fast, that its products could not be converted into nucleoplasm or chromatin with sufficient rapidity so as to be in a condition to fall apart as small cells, as a consequence of the action of the direct process of fission." The evidence for this is the supposed fact that the nucleoplasm or chromatin, in higher forms, is derived by constructive metabolism from cytoplasm, and is the end-product of the latter.

"The secondary evolution of a cytoplasmic field led to a process of divergent evolution, or in the production of two

kinds of cells, the most primitive or ancestral of which was poorly provided with cytoplasm, while the secondary form was provided with a thick cytoplasmic envelope."

"The primitive, minute form of cell is to be identified as the asexual one, which afterwards became 'male,' while the large, overgrown type of cell, loaded with cytoplasm and its secondary products, is to be identified as 'female,' or as a cell on the way towards disruption into male cells, which tendency it still betrays in the process of extrusion of polar bodies. The arrest of this process of fragmentation in the case of such large cells loaded with cytoplasm, led to the evolution of the ovum from the spermatogonium, or such a cell as was primarily destined to produce male cells as a result of its further fission."

"The male state is therefore the primitive one, and in the prodigious fertility of the male represents the primordial, asexual, flagellate types. The female cell is a secondary and derived form, developed after a cytoplasmic field has been evolved, and after cell-aggregates began to become coherent."

[To all this it must be said that it is extremely hypothetical.

It is an hypothesis that the primitive units were bacteria-like.

It is an hypothesis that in them chromatin preponderated over cytoplasm, and this is an unlikely supposition if chromatin be the end-product of cytoplasmic metabolism.

It is an hypothesis that chromatin is a product of the metabolism of cytoplasm.

It is a confusion of thought to speak of these primitive asexual units as "male," for the term is purely relative, and has no meaning apart from its correlate "female."]

So far, then, Ryder's most important conclusions are—(1) that in the male reproductive cells chromatin preponderates, in female reproductive cells cytoplasm; (2) that the primordial asexual units were like male cells in having preponderant chromatin, and that the male state is the primitive one; (3)

that by cumulative integration, cells with preponderant cytoplasm were evolved, and thus arose female cells.

The subsequent steps in the argument are as follows:—"When individuals became developed in which the physiological functions of the individual were so adjusted automatically, through a correlation of those functions, as to impede the production of chromatin or nucleoplasm, presumably through the too rapid action of cumulative integration, cytoplasm was produced in a preponderating measure, the spermatogonia were hypertrophied and discharged before complete maturation as ova. In this way femaleness arose, and as "sex" thus became reflected in the physiological tendencies of the individuals of a species, some became male and others female. This carried the principle of the physiological division of labour beyond organs, and extended it to individuals of the same species. The female is a repressed male state."

Ryder's interpretation of observable phenomena may be now summed up:—

"Male and female sexual products were at first, and still continue, to be dehisced as useless products of over-assimilation, or as a consequence of the cumulative action of integration."

Suppose an organism with a number of primitive reproductive cells. If it be a female, over-growth is diverted to the enlargement of the reproductive cell, to a preponderance of its cytoplasm, to hypertrophy. There result ova, which, except in the case of parthenogenesis, have lost the power to undergo spontaneous segmentation. These "hypertrophied spermatogonia" may, however, give off polar bodies as "a phylogenetic reminiscence of the asexual or male flagellate state." But if the organism be a male, the primitive reproductive cells, or spermatogonia, retain their tendency to divide, in the process cytoplasm is reduced to a minimum, the primitive flagellate condition recurs, and, "as a consequence of the reduction of its cytoplasmic field, the male cell becomes incapable of further independent development."

"The exhaustion of the central controlling mass of nucleoplasm or chromatin in the ovum, after expulsion of the polar

bodies, together with the great size of the egg, has rendered it passive. The recurrence of the minute flagellate condition as 'male' has rendered the male element active."

"The male and female elements became reciprocally attractive to one another (sometimes through the production of certain chemical substances in the vicinity, Pfeffer), and in that their idioplasm is less different from one another than that of other cells there is no bar to their fusion, which is also favoured by the fact that in the male cell, with its preponderant chromatin, there is now an attraction or need developed for more cytoplasm similar to its own diminished quantity, while conversely there is a similar need or attraction developed in the egg for additional chromatin, in consequence of its preponderating cytoplasm. This leads to the highest form of cumulative integration, through direct fusion of the male and female elements, or what I shall call reciprocal integration without loss of molecular identity, or, as it is commonly called, to 'fertilisation.' 'Fertilisation' is a reciprocal restoration of the equilibrium between the chromatin or nucleoplasm, and the cytoplasm of both ovum and spermatozoon; this takes place, not with accompanying molecular disintegration, but by the actual fusion of both elements without the sacrifice of the molecular identity of either. Mutual digestion is not possible, for both elements are already composed of similar molecules. This molecular similarity constitutes the means through which the hereditary traits and tendencies of the male and female are transmitted."

The development which follows fertilisation "is rendered directly possible only in virtue of the fact that there is a large cytoplasmic field in which nuclear motion and growth can take place in three dimensions temporarily without access of nutriment, while the resulting segmentations are coherent, and tend to take place in such order and relation as to produce a being similar to the parent."

"The most important result of the evolution of sexuality is the physiological process of nuclear substitution through reciprocal integration or 'fertilisation,' thus blending and superposing matter and energy from two sources, and causing the latter to be potentially stored. Hunger has brought

about the material overflow, the divergence of the sexual elements from a common basis has ended in the production of countless adaptive modifications and the evolution of 'species,' while the accessory devices favourable to conjugation, which have been slowly and adaptively evolved, have led to a gradually intensified expression of passion and love, which have become important motive forces in the drama of evolution at large."

With many of Mr Ryder's conclusions we must agree. Some of them had been already expressed in the "Evolution of Sex." His insistance on the fundamental importance of growth as the great peculiarity of organisms; his interpretation of sexuality in terms of nutrition; his protest against teleological explanations of facts, *e.g.*, of sexuality as a means of securing variation; his insistance on the reproductive factor in evolution, seem to us in essential agreement with what was advanced in the work cited. Moreover, though we do not regard the male cell as "anabolic," we certainly agree with him in seeking for more precise statements as to the yolk of ova than are to be found in the "Evolution of Sex," and we agree that "reciprocal assimilation," or "reciprocal integration," is more accurately descriptive of one of the aspects of fertilisation.

We differ, however, from Mr Ryder on at least three important points:—

(1) We maintain, with the correction already noticed, the general thesis expressed in the "Evolution of Sex."

(2) We regard his general theory as involving too many unestablished hypotheses, *e.g.*, the preponderance of chromatin over cytoplasm in primordial units, the origin of chromatin as a metabolic product of the cytoplasm.

(3) We distrust all conclusions as to physiological facts based upon morphological distinctions such as that between cytoplasm and nucleoplasm. For if we lay aside all bias, it must be confessed that both terms cover vast areas of ignorance. What is cytoplasm or nucleoplasm? What relation does the nucleus bear to cell and its metabolism? Is Auerbach right in finding a qualitative difference between the chromatin of the sperm and that of the ovum?

Even supposing Ryder's conclusions to be justified, we cannot see that he has done more than add a morphological contrast to the physiological contrast between the sexes, as already indicated in the "Evolution of Sex."

8. HARTOG'S THEORY.—In 1891, Prof. M. M. Hartog published, in the *Quarterly Journal of Microscopical Science*, a very important paper entitled, "Some Problems of Reproduction: A Comparative Study of Gametogeny and Protoplasmic Senescence and Rejuvenescence." This paper is based on the author's concrete researches, and though it seems to us to include an unduly large contingent of new terms, its orderly classifications, its trenchant criticisms, and its acute suggestions, are all important.

It has for long been a favourite theory of fertilisation that the sperm brought to the ovum something which *replaced* what the ovum had parted with in forming polar bodies. Thus, according to Minot, Balfour, and van Beneden, the germinal vesicle lost in forming polar bodies some sexual substance, which was replaced by the sperm in fertilisation; while according to Weismann, all that is lost and replaced is a certain quantum of nuclear substance. Now Hartog begins by pointing out that this theory, though based on facts occurring among numerous Metazoa, has been extended by an act of unwarranted faith (not uncommonly illustrated in scientific theories) to all other cases of fertilisation.

A study of the facts has led him to doubt all "replacement theories," and to come to the following conclusions:—(1) "That the most general, but not universal, feature underlying the preparations for fertilisation, is the specialisation of gametes by rapidly repeated divisions of a cell—the gametogonium; (2) that the alleged nuclear excretions in the Metazoan egg and the ciliate 'gamete,' etc., represent true gametes arrested in their development; (3) that the so-called 'excretions' of protoplasm in plants are of various kinds, many of which are homologous neither with the former processes nor with one another; (4) that the use of the rapid preliminary divisions is a purely physiological one; that is, to induce by exhaustion the same reproductive

incapacity that would otherwise require a long series of slowly repeated divisions."

According to Hartog, fertilisation is a process of rejuvenescence or constitutional invigoration. Cytoplasm and nucleus form, as it were, a firm, which in course of time—especially after repeated rapid divisions—ceases to be in a healthy state. The prolonged association of cell and nucleus has evil effects. In ciliate Infusorians which divide repeatedly and are unable to conjugate, Maupas has shown that senescence sets in; so is it with other gametes, and fertilisation is one of the remedies for the disease. In fertilisation a new cell-nucleus firm is constituted.

In the absolutely asexual (agamous) Monadineæ, rejuvenescence can be secured only by rest. In many apogamous and self-fertilising organisms, a change of the mode of life is the cure. In higher Monadineæ and in the Myxomycetes, the migration of nuclei in plasmodium-formation serves the same end. In isogamy, plural or binary, there is nuclear union (karyogamy) as well as cytoplast-union (plastogamy). In most cases karyogamic rejuvenescence has become essential to the preservation of the species.

"Rapidly repeated nuclear fissions, without sufficient interval for nutrition and recovery, may lower the vital energy or constitution of the cell, and accelerate reproductive incapacity; and this may be the physiological import of the fissions that so frequently differentiate the gamete, and determine its obligatory character." "The constitutional weakness of the later terms of a cycle of fissions is largely due to the continuance of the association of nucleus and cytoplast unchanged."

"From considerations of (*a*) the known functions of the nucleus; (*b*) its chemical composition; (*c*) the effects of rest, change of form, or change of habit (polymorphism and heterœcism) in effecting rejuvenescence, and often replacing karyogamy: it is suggested that the evil effects of the prolonged association of cell and nucleus are due (*a*) to the nucleus responding less actively to the stimuli from the cytoplasm; (*b*) its consequently inadequate directive-power; (*c*) to the resulting bad performance of its work

by the cytoplast; (*d*) to the imperfect nutrition of the nucleus; (*e*) the failure of the cell as an organic whole."

"Replacement theories of fertilisation are inadmissible, since all fail to account for one or more of the following facts:—(*a*) multiple isogamy; (*b*) the non-discrimination of the broods of exo-isogametes into two categories, of which members of either would pair with those of the other category, but not of their own; (*c*) the absence of 'excretion phenomena' of any kind in so many cases of gametogeny; (*d*) the existence of true parthenogenesis of male as well as female gametes; (*e*) the formation of a male individual from the exclusively female oosphere of the hive-bee." The peculiar value of Hartog's work, of which our few citations can convey but an inadequate impression, lies (1) in the width of the concrete survey which he has taken, and (2) in the resulting rehabilitation of the theory of rejuvenescence in a manner which recognises the physiological complexity of the problem.

A criticism which Hartog makes of the "Evolution of Sex" appears to us of importance. It is this. He does not believe in the least "that the male brings 'katastates,' the female 'anastates,' which combine to make the zygote a perfect organism." He does not believe in any such "entities." Moreover, "if we accepted Geddes and Thomson's view that there are actually entities that we can term anastates and katastates, we should have to reject their conclusions, and say that the preliminary disorganisation of the germinal vesicle is the elimination of its anastates; for henceforward all the phenomena manifested are katabolic, even without the advent of the male; and in ova which are not parthenogenetic, the resumption of anaboly is henceforward impossible."

In reference to this, we may note (1) that we regard the physiological interpretation of the polar bodies given in the "Evolution of Sex" as crude. It was there suggested that the formation of polar bodies was an extrusion of "katastates," which were replaced in fertilisation by katastates from the sperm. As the chromatin rods of the polar bodies do not seem different from those which remain in the female

[illegible]

[illegible] We believe that they are chemical substances characteristic of the metabolism of ovum and sperm respectively, [illegible] the physiological contrast between them. [illegible] we believe that the renewal of the [illegible] has a [illegible]. [illegible] Hartog's criticism is [illegible] for [illegible] statements should not be [illegible] where ignorance [illegible].

[illegible] Hartog's [illegible] He finds a clue in the history of [illegible] the gametes are of three sizes— [illegible] and [illegible]; the [illegible] are said to be $a-a$, $b-b$, [illegible] $a-b$, $a-c$, and $b-c$ [illegible]; $c-c$ does [illegible] concurrent with its enlargement, the [illegible] too inert to form isogamous unions." [illegible] may conceive that, the gametogenic divisions in a [illegible] being inconstant, broods of gametes would be formed, whose size was inversely proportional to the number of the

brood; the extreme forms would be small active gametes and large sluggish ones respectively. As the latter are ill-fitted to conjugate among one another, in the struggle for pairing the small numerous active ones would be most likely to find pair with these large ones, and the rejuvenesce of such unions would be the more efficacious, because of the difference of temperament between the parent gametes. The middle forms being produced in smaller numbers than the little gametes, and less useful either way, would tend to disappear. The difference of size between the micro- and mega-gametes would tend to increase, and a division of labour take place—the megagamete tending to accumulate nourishment to give the zygote a good start, the microgamete gaining activity and delicate sensibility; and by this differentiation of temperament the zygote would be the gainer. This I take to be the origin of sex. Once started in some such way, the difference of temperament between the gametes would tend to be more and more accentuated and, so to say, crystallised, and this would be as it were anticipated, first in the organs, and then in the individuals producing the gametes."

We have quoted this at length because of its importance as a corroboration of one of the general conceptions expressed in the "Evolution of Sex." It seems to us legitimate to express the facts in another form in saying that in the cell colonies, which produce few large heavy-laden gametes, the ratio $\frac{A}{K}$ is greater than in those which produce numerous small active gametes, and that in the gametes "the differentiation of temperament" may be similarly stated. "Temperament" does seem a big word to apply to gametes, but as it must simply mean physiological habit, and as that must have a chemical basis, we still find it useful to maintain that the microgamete brings to the megagamete, certainly not "entities," perhaps not katastates, but chemical stuffs whose nature is determined by the fact that in the microgamete, and in the male colony which produces it, the ratio $\frac{A'}{K'}$ is less than the ratio $\frac{A}{K}$ in the megagamete and the female colony whence it sprang.

But we are more interested in Hartog's corroboration of the general idea. "I accept then," he says, "one main thesis of the 'Evolution of Sex,' that male and female are distinguished by their respective temperaments," or, as we should say, by their contrasted metabolic ratios.

9. WEISMANN'S THEORY OF AMPHIMIXIS.—In 1891, Professor Weismann, whose influence upon modern biology has already been of the highest importance, published an essay entitled "Amphimixis oder die Vermischung der Individuen," the conclusions of which, if ultimately established, are bound to introduce fundamental changes in our conception of sexual reproduction. Weismann's essay has been translated in the second English edition of his collected papers, where it bears the title "Amphimixis, or the Essential Meaning of Conjugation and Sexual Reproduction." As the essay is one of considerable length and complexity, it may be convenient to separate the main conclusions from the detailed discussions which they involve.

His main object is "to express, more fully than before, the thought that the process which we are accustomed to regard as reproduction, is not reproduction only, but contains something *sui generis*, something which *may* be connected with reproduction proper, and in the higher plants and animals *is* so connected, but which is entirely separate in the lower organisms." This "something" is amphimixis, or the mingling of the different hereditary tendencies of two individuals.

Weismann maintains that the progress of science, *e.g.*, what we have come to know about parthenogenesis, maturation, the parallel processes of oogenesis and spermatogenesis, the behaviour of the chromatin rods, etc., is in favour of his conclusion that fertilisation is not a "vitalisation of the germ," nor a "rejuvenescence of vital processes," but that it "has no significance, except in the union in the single offspring of the hereditary substance from two individuals." He believes that the prevalent conception of fertilisation as a renewal of life is bound up with a lingering credence in a "vital force." He completely rejects the idea of the interaction of two opposed sexual cells of different qualities, or of any

fertilising substance, except in so far as the sperm-nucleus restores to the ovum a certain quantum of nuclear substance (equivalent to that lost in forming polar globules), thus rendering its *quantity* sufficient for development. To put it more concretely, he believes that two female pronuclei in an ovum might be quite as effective as the normal male and female pronuclei, and accepts Boveri's remarkable observation that the nuclei of two spermatozoa introduced into a denucleated ovum of an *Echinus* were sufficient to result in development.

In short, Weismann holds "in opposition to the rejuvenescence theory, that there is no polar antithesis, and that, in the union which is the essence of fertilisation, the nuclear loops contribute neither male nor female principle, but a paternal and maternal substance, and that the significance of fertilisation is nothing more nor less than a mingling of the hereditary tendencies of father and mother."

(*a*) *The Significance of Maturation.*—According to Weismann's original hypothesis as to meaning of polar globules, the first division of the germinal vesicle was a removal of purely ovogenetic idioplasm, the second was a halving of the number of ancestral units contained in the germ-plasm proper.

But O. Hertwig, in an exceedingly valuable research, has recently drawn attention to the remarkable parallelism between ovogenesis and spermatogenesis, observing that in both cases a similar "reduction division" of the nuclei takes place. Thus in *Ascaris megalocephala*, var. *bivalens*, the subject of so many famous investigations, the primitive reproductive cells of both sexes have four chromatin rods; in both cases these are first multiplied into eight, and then twice halved, so that there remain only two alike in spermatozoon and in female pronucleus. Moreover, Hertwig's researches "prove that the nuclear idioplasm of all polar bodies, as well as that which is retained in the egg, must be germ-plasm."

Accepting Hertwig's observations, Weismann acknowledges that his "previous interpretation of the first polar body as the removal of ovogenetic nucleoplasm from the egg must

fall to the ground. But still maintaining that the polar bodies serve to reduce the hereditary substance, he sets himself to answer the question, "Why should the nuclear substance be doubled only to be halved again?"

His answer is as follows:—The germ-plasm, or active substance of the nuclear rods (or idants), may be thought of as built up of innumerable ancestral plasms or specific hereditary units (or "ids"), "each one of which, if it alone dominated the ovum, would be capable of guiding the whole ontogeny and of producing a complete individual of the species, but cannot be divided without losing this power." The significance of the longitudinal splitting of the idants, and the consequent doubling of their number, is an increase in the number of possible combinations. It lies in the attempt to bring about as intimate a mixture as possible of the hereditary units of both father and mother. "The significance of the reducing divisions in male and female germ-cells is a double one, first, the diminution of the ids by a half, and secondly, the *arrangement* of the idants in fresh combinations. The reducing division halves the number of idants so that one daughter-nucleus receives one set, and the other another set of ancestral plasms; it leads to a halving of the number of idants in such a manner that the most varied combinations can arise. Thus if there were twenty idants (and there are sometimes more), a process similar to that in *Ascaris* would yield 8,533,606 possible combinations. In short "the doubling of the idants before the 'reducing division' renders possible an almost infinite number of different kinds of germ-plasm, so that every individual must be different from all the rest. And the meaning of this endless variety is to afford the material for the operation of natural selection."

(*b*) *Parthenogenetic Reproduction.*—In eighteen species of parthenogenetic animals, viz., in eight Daphnids, a Branchiopod, two Ostracods, three Rotifers, and four Insects, it has been found that in the maturation of the ovum only one polar division occurs.

Whether the single polar division is an ordinary "equal division," dividing the collective ancestral plasms into two

equal and similar groups, or is a "reducing division," which has been preceded by a doubling of the number of idants, is uncertain; but Weismann regards the second possibility as the more likely.

If it be a "reducing division," there will be fresh combinations of idants, so that "in parthenogenetic as well as in sexual eggs a change may take place in the constitution of the germ-plasm during successive generations."

And this conclusion, at least, has been experimentally confirmed by Weismann's observations on *Cypris reptans*, in which he demonstrated parthenogenesis for no less than forty successive generations. Contrary to his former opinion that purely parthenogenetic species entirely lacked the capability of transformation by means of selection, he now recognises that "they do possess this power to a certain extent." "In parthenogenesis individual variation exists, which, as in bi-sexual reproduction, has its foundation in the composition of the germ-plasm itself, and thus depends on heredity, and is itself inheritable."

When it is asked how parthenogenetic eggs may have arisen from those which require fertilisation, two answers seem to Weismann possible. (1) By the suppression of the second polar division the egg-cell would retain precisely as much nuclear material as it would have contained if fertilisation had followed the expulsion of a second polar body. It is in this way that Weismann believes that regular parthenogenesis has arisen. (2) But, as Blochmann observed, the egg of a hive-bee, which develops parthenogenetically into a drone, exhibits two polar divisions, and Platner has observed the same in the parthenogenetic eggs of *Liparis dispar*. In such cases of exceptional parthenogenesis, Weismann supposes that "the germ-plasm in the egg, after having been reduced to half its normal amount, possesses, in some unusual way, the power of increasing to double."

(*c*) *Amphimixis as the Significance of Conjugation and Fertilisation.*—As the result of the investigations of Maupas, R. Hertwig, and others, we know that in the conjugation of two ciliate Infusorians, there is an exchange of equal amounts of nuclear substance. The micronucleus undergoes repeated

divisions, all the daughter-nuclei disintegrate except two in each unit; these copulatory nuclei may be termed male and female. The male copulatory nucleus leaves the animal in which it arose, passes to the other conjugate, and there unites with the female copulatory nucleus.

This process Weismann interprets as amphimixis—the mingling of the hereditary idioplasms of two individuals. The micronucleus of Infusoria possesses nuclear rods or idants; among these there may be individual differences; before conjugation there is a preliminary enlargement, which Weismann assumes to be connected with a doubling of the idants by longitudinal division; the first and second divisions are "reducing divisions," the third is an "equal division"; the result is a fresh grouping of the idants, just as in the analogous "reducing divisions" of the egg and sperm. "Variety of individual character in the hereditary substance is thus brought about by means of these divisions."

The two conjugating nuclei are essentially similar, like the nuclei of Metazoan sex-cells, according to Weismann, Strasburger, and O. Hertwig. The import of their fusion is no rejuvenescence or vitalisation, but a mingling of hereditary tendencies. And as Weismann now holds that "a belief in the inheritance of acquired characters by the highly differentiated Protozoa, as well as by Metazoa, must be opposed," and imagines that "the phyletic modifications of Protozoa arise from the germ-plasm, that is from the idioplasm of the nucleus," he "can understand why nature has laid so much stress on the periodical mingling of the nuclear substance of two individuals—why she has introduced amphimixis among these animals." "Clearly it has arisen from the necessity of providing the process of natural selection with a continually changing material, by the combinations of individual characters."

So, in conclusion, the deeper significance of every form of amphimixis consists in the creation of hereditary variability. Nature has given it the widest possible range by rendering unicellular germs incapable of developing alone. And as in nature "the useful becomes necessary as soon as it is

possible," amphimixis became and continues to be necessary because of its deep and essential use. The periodicity of its appearance depends on adaptation, thus parthenogenesis is chiefly found in very prolific species. In short, amphimixis is no indispensable condition, no renewal of life or "rejuvenescence," nor inseparable from the continuance of vital processes; it is a mingling of hereditary qualities, and as such an essential advantage in the maintenance and modification of species.

Critical Notes.

No one who reads Weismann's important essay with carefulness can fail to recognise that he has to deal with a thinker who will not fail to alter his positions whenever fresh facts appear to him to demand it. For with perfect frankness he now rejects his previous interpretation of the first polar body, his belief in the non-variability of parthenogenetic animals, and his admission that in unicellular organisms external influences could directly call forth hereditary changes. Moreover, although his essay abounds in hypotheses, it cannot be denied that the entire theory is full of attractiveness; and there is some reason to justify hypothesis, as he says, on the ground that "future research will be more profitable if we endeavour to test some settled theory, instead of making observations with no end in view." Such being Weismann's scientific mood, we feel sure that he will appreciate the spirit of dissentients, who seek to maintain the old position as to fertilisation until that prove either untenable or stronger than he deems it. For in regard to these difficult problems, it is only by criticism and counter-criticism that we shall at length grasp what is true.

First of all, we would notice, what Weismann himself recognises, that his "view as to the effect of amphimixis in originating variability may be perfectly correct, without the essence of fertilisation or of conjugation being thereby explained." It is evident that we may accept Weismann's positive conclusion that fertilisation is a mingling of t

sets of hereditary qualities or transmitting substances, while refusing to accept his negative conclusion that it is nothing more. We may recognise two phenomena in fertilisation: (1) the mingling of hereditary qualities, and (2) a dynamic stimulus brought about by the union of sperm with ovum. Even Weismann admits that in fertilisation there is not only amphimixis, but the restoring to the ovum a certain quantum of nuclear substance, without which development does not proceed. Even he, as it seems to us, has to recognise two phenomena, one of specific, the other of individual importance. Although he opposes every suggestion of rejuvenescence, he admits that the presence of a certain amount of nuclear substance in an ovum is essential, and this (brought about normally by fertilisation) must have a dynamic effect, as to the physiology of which we are ignorant.

Weismann points out that "we are saturated with the old notion that the egg cannot develop without fertilisation, that fertilisation is the same as vitalisation." "Are we not aware that, under certain circumstances, the egg can develop without fertilisation?" "No one would have regarded fertilisation as the vitalising of the egg if the great majority of ova had developed parthenogenetically, or if science had first become acquainted with parthenogenesis, and, later on, with fertilisation." The notion is bound up with the ancient belief in a vital force. To this forcible indictment, it may be answered that if the great majority of animals had developed by spontaneous generation, no one would have regarded biogenesis as an important fact. We have to consider the facts as they are, and certainly parthenogenetic forms are in a very small minority. [Why they should be in a minority, and that of restricted range, Weismann does indeed seek to explain, as we shall afterwards consider.] Nor do we see that the reference to a belief in "vital force" is particularly relevant in this discussion. For, without entering upon a time-honoured controversy, we fail to see that those who believe that the sperm physiologically stimulates the ovum are any nearer a superstitious belief in a vital force than those who observe

that a Bacterium has a certain physiological effect on cells with which it comes into close vital relations. That we cannot definitely explain the nature of the fertilisation-stimulus, in which we believe, is hardly an argument against its existence. We are also at a loss to express the nature of the relation between nucleus and cell-substance, the importance of which no one doubts.

We have said that Weismann's essay abounds in hypothesis. As his theory is attractive, it may perhaps tend to caution if we bring together a few of these.

(*a*) It is not by any means certain that the chromatin rods are quite so unique in their importance as Weismann and many other biologists constantly assume. "Everything which occurs in the cell, including the rhythm and the manner of its multiplication, depends upon the nuclear substance"—is a conclusion which appeals to our ignorance. We know so humiliatingly little about such matters that we hesitate in accepting a large theory, one of whose postulates is that the chromatin rods have a monopoly of importance. Is it not likely enough that the morphologists of the cell, in discovering a substance which responds to their stains, and whose behaviour can be watched, have exaggerated its importance and depreciated that of less conspicuous elements? Does not the recent discovery of the central corpuscles, with their attractive spheres, lead one to be extremely cautious in fixing the essential qualities of life in any one visible structure? Of course it is open to Weismann to say, as he does, that the centrosomata may be controlled by germ-plasm, and that they may be derived from the nuclei. But there is no end to such may-be's. He urges, moreover, that even if the centrosoma be part of the cell-body, its activity depends upon the internal conditions of the cell, which "is primarily determined in all its qualities by the nuclear substance." But this last clause is precisely what has to be proved, else the contention is simply an argument in a circle. Nor can we forget that there is more in the nucleus than chromatin rods, and more in the cell-body than a centrosoma, and that even

if the idants be the material basis of hereditary qualities (which seems to us a very natural assumption), the possibility is by no means excluded, that associated substances may have a dynamic influence in fertilisation. We acknowledge, of course, that Weismann is justified in making out the strongest possible case for the unique importance of the chromatin rods: it seems to us that we are also justified in maintaining that the cytoplasm has some claims to be considered.

(*b*) As we have seen, Weismann attaches great importance to the "reducing divisions" of maturation, which remove half a set of hereditary predispositions and permit of the arrangement of the remainder in fresh combinations. It cannot be denied that this speculation is exceedingly ingenious; if the facts are really as Weismann believes, an important contribution has been made to our knowledge of the morphological aspect of variation. But it must be noticed (1) that the ingenious interpretation owes its value to an antecedent hypothesis as to the nature and arrangement of the ancestral plasms or "ids" within the idants,—an hypothesis which may or may not be true; and (2) that it is quite possible that the processes of sperm- and ovum-maturation in *Ascaris megalocephala*, var. *bivalens*, may not be typical. Weismann considers this last objection with the same carefulness which, Darwin-like, he displays throughout in anticipating difficulties, but whether his clever harmonising of Henking's somewhat divergent observations on *Pyrrhocoris* will stand remains to be seen. The homology between the formation of spermatozoa and ova, between the two divisions of the sperm-mother-cell and the formation of two polar bodies, has been traced by Hertwig in *Ascaris*, by Platner in butterfly and snail, and to some extent by Flemming in the salamander; but it is a matter of opinion whether "we may well believe that we are dealing with a process of general significance, and one which is repeated during the formation of the sexual cells of, at any rate, all the higher Metazoa, in essentially the same way." It seems to us that there remain at present a large number of described cases of spermatogenesis in which a double "reducing

division" has hitherto escaped notice, and that the extremely unsatisfactory state of our knowledge in regard to ovum-maturation in reptiles, birds, and mammals should lead us to speak cautiously of "all the higher Metozoa." It may be said, of course, that this is an argument *ad ignorantiam* again, but our contention is made in no polemical spirit nor with any prejudice against the probability of Weismann's conclusion, merely with the desire of indicating a few of the gaps which remain in his demonstration. It can hardly be taken for granted that all his readers are as conscious of these as he himself is.

(*c*) It will be remembered that Weismann inclines to the belief that the single polar division of normally parthenogenetic ova is a "reducing division," preceded by a doubling of the idants. This, which is an important assumption, enabling Weismann to explain the variability of parthenogenetic organisms, is only "based upon probability." When we turn to his discussion of exceptional cases of parthenogenesis, *e.g.*, in the bee-eggs which become drones, or in *Liparis dispar*, in which the eggs exhibit two polar divisions, we are confronted with another ingenious hypothesis. As Weismann is convinced that a certain amount of germ-plasm must be present in the ovum if development is to proceed—which is also an assumption—he agrees with Strasburger that the germ-plasm of these exceptionally parthenogenetic ova "possesses, in some unusual way, the power of increasing to double." By such hypotheses any difficulty may be overcome; but one naturally looks for facts demonstrating that the doubling actually occurs, as Weismann may demand from us observations showing that it does not. Moreover, supposing that the increase of the germ-plasm to double do actually take place, it seems to us difficult to accept the opinion that "the difference between eggs which are capable of parthenogenetic development and those which are not, must be quantative and not qualitative." One would naturally think that ova thus unusually endowed were entitled to be called qualitatively different from those which have no such power.

10. CONCLUSIONS.—(*a*) Many biologists will, we believe, accept the following propositions as statements of facts, which must be distinguished, of course, from such inferences as we or others may draw from them:—

That organisms may be arranged in series of contrasted greater or less activity—activity being measured by the amount of movement, or, in more general terms, by the rate of transformation of potential into kinetic energy.

That the sexes are examples of this general contrast, the males being the more active, the females the more passive; that the reproductive elements produced by the two sexes are in a similar manner contrasted, the sperms being much more active than the ova; and that the incipient sexual dimorphism of unicellular organisms is also parallel.

That associated with this difference of physiological habit are differences of (*a*) size, (*b*) form, and (*c*) chemical composition; the female being generally larger, less adapted for movement, and with a relatively greater store of reserve material.

That the sex of the adult may, in some cases, be determined by the nutrition of the embryo, more abundant nutrition favouring the production of females rather than of males.

(*b*) What we have sought to emphasise is that in contrasting the sexes and their reproductive elements (and all active and passive organisms), attention must, as precisely as possible, be expressed in contrasted ratios. The storage of potential energy in a female need not be absolutely greater than in the corresponding male (though in some cases, *e.g.*, the cochineal insects it is so); our contention is that in the female the ratio $\frac{A}{K}$ is greater than the corresponding vital ratio in the male. In the great majority of cases of the food assimilated and stored by a male organism the greater amount is used, after growth has ceased, for movement and for maintaining the general functions of the body, the reproductive function making relatively small demands on the nutritive store; while in the female organism a relatively

great amount is used for the formation of ova, or for the nutrition of the embryo. The female organism is one in which the general ratio $\frac{A}{K}$ (the mean of many ratios) is greater than the corresponding general ratio in the male.

(*c*) As to the origin of sex, which we take to be the origin of two contrasted physiological habits, we adhere to what is suggested in "The Evolution of Sex," and virtually accepted by Hartog (see p. 269). We believe that the origin of sex is clearly illustrated by the history of such forms as *Pandorina* and *Volvox*. It is of course possible, and indeed necessary, to push the inquiry a step further back, seeking some explanation why a *Pandorina* should produce mega-, meso-, and micro-gametes, or why a *Volvox* should be parthenogenetic, hermaphrodite, female, or male, as the case may be. To this question it does not seem to us possible to give any answer other than that which refers the diverse physiological states to diverse environmental conditions. The question is in fact as ultimate as that which asks how animals and plants arose as divergent branches of the tree of life.

As to the reasons why the sexual dimorphism should be fostered in the struggle for existence by the usual process of natural elimination, there is, as the preceding reviews will show, considerable difference of opinion. According to Weismann, all the facts of sex and sexual reproductions are adaptations to secure amphimixis, or the mingling of individual characteristics, whence arises the crop of variations which natural selection thins. According to others, who believe in rejuvenescence theories of fertilisation, the dimorphism secures the continual formation of new physiological associations or of new chemical combinations.

(*d*) While it is possible for any one to suppose that all the characters of the sexes are purely adaptive, arising from indefinite variations reduced to advantageous lines by natural elimination (or selection), and while we ourselves are compelled to adopt a similar explanation in regard to certain exceptional facts of sex, such as the fact that many male mammals are larger than their mates, the following considerations may be noticed:—

(1) Even in regard to the secondary sexual characters, which have been and are still regarded by many as good illustrations of the results which may be achieved by the operation of natural elimination on an abundant crop of indefinite variations, Wallace's criticism of Darwin's theory of sexual selection has reopened the question, while his own physiological explanation is parallel with that suggested in "The Evolution of Sex" for the general facts of sexual dimorphism.

(2) Sexual dimorphism appears in many forms among organisms, and those who would explain it as purely adaptive, are driven to give as many special explanations in terms of adaptation as there are varieties of reproductive habit, while the single "constitutional theory" covers nearly all known cases.

(3) Further, it is to us impossible to conceive of the way in which a favourable feminine variation, such as size suitable for nurturing an embryo, can always have been entailed upon the female sex. It is true that it is easy to say that those species and individuals in which this mode of entail or inheritance was not established would be eliminated, still the difficulty remains, how in any case is the entail kept up if it be not the expression of a constitutional characteristic.

(*e*) Finally, it may be noted that the suggestions discussed in the present paper are in harmony with many other attempts which are now being made from different sides to prosecute an analysis beneath the possibilities of elimination or selection to the origin of the variations themselves. And if in regard to this fundamental problem we have been able to say but little, we may perhaps have succeeded in emphasising the fact that the problem has to be faced. It is indeed to some lack of perception of the fact that primary factors, originating variation, must lie behind the secondary factors, directing variation, that we must refer the misunderstandings which continue to prevail in the camps of Neo-Lamarckians and Darwinians.

XXII. *On the British Species of* Asterolepidæ. By R. H. Traquair, M.D., F.R.S.

(Read 19th March 1890.)

In a paper entitled "Notes on the Nomenclature of the Fishes of the Old Red Sandstone of Great Britain," published in 1888, I adopted four British genera of Asterolepidæ, namely, *Asterolepis, Pterichthys, Bothriolepis,* and *Microbrachius.* To amend, to some extent, the conclusions arrived at in that paper is the object of the present communication.

Pterichthys.

In 1888 I retained the following species:—

A. Terminal division of arm slender, tapering.
  1. *Pterichthys Milleri,* Ag. (including *P. latus,* Ag.). Inferior surface of carapace broadly ovate.
  2. *P. quadratus,* Eger. Inferior surface of carapace peculiarly short in proportion to its breadth.
  3. *P. cornutus,* Ag. (including *P. testudinarius,* Ag.). Inferior surface of carapace narrowly ovate.

B. Terminal division of arm expanded, abruptly pointed.
  4. *Pterichthys productus,* Ag. (including *P. cancriformis,* Ag.). Inferior surface of carapace narrowly ovate.
  5. *P. oblongus,* Ag. Inferior surface of carapace long and narrow, sides nearly straight.

Nevertheless, both in the *Geological Magazine* and in a paper on the Asterolepidæ read before this Society,[1] I expressed my suspicions that these apparently different forms might, after all, belong in reality to one and the same species.

In the second part of the "Catalogue of the Fossil Fishes in the British Museum," published in 1891, Mr A. Smith Woodward adopted my views, with this addition, that he, having fortunately discovered the type of *P. latus,* Egerton, which I had not seen, also included that supposed species among the synonyms of *P. Milleri,* Agassiz. He also corrected a mistake into which I had fallen by inadvertence, namely, in adopting the name *cornutus* instead of *testudinarius* for the other species with slender terminal arm-joint, seeing

[1] Proc. Roy. Phys. Soc. Edin., vol. x., part i. (1888-89), p. 32.

that in Agassiz's list the name *testudinarius* occurs before *cornutus*, and must therefore be preferred, according to the usual rules of nomenclature.

The more I study the subject, the more I become convinced that still further reduction of the supposed species of *Pterichthys* is necessary. Accordingly, I not only heartily concur in the suppression of *quadratus*, and its fusion with *Milleri*, but I also would hand over *testudinarius* (including *cornutus*) to the same fate. The only difference between *P. Milleri* and *P. testudinarius* which struck me in 1888 was that, in the former, the under surface of the carapace was "broadly ovate," while in the latter it was "narrowly" so. But the subsequent re-examination of this question has convinced me that this is a character on which no reliance can be placed, and that therefore *testudinarius*, like *quadratus*, must disappear from the list.

There remain for consideration the two forms *P. productus* and *P. oblongus*, in which the terminal joint of the arm is peculiarly expanded and abruptly pointed. This character alone distinguishes *P. productus* from *P. Milleri*, and as these two forms constantly occur together in the same beds, I must own that I am strongly possessed with the idea that the difference in point may be a sexual one. But in *P. oblongus* we have an additional character in the peculiar narrowness of the ventral aspect of the carapace, of which the edges are also nearly straight; and if this mark be specific, and the expansion of the terminal joint sexual, then the opposite sex of *oblongus* has yet to be discovered. It seems more probable that there is here no distinction of species, and that the difference in form of the under aspect of the carapace is merely varietal, though we can also readily, in any collection of specimens of *Pterichthys*, pick out those which show the characters of *oblongus*.

In this condition I must therefore leave the question. Though strongly suspecting that there is but one species of *Pterichthys* in the Lower Old Red Sandstone of Scotland, and that the distinction of the arms is a sexual one, I cannot prove that this is the case. I therefore—judging from what seem to be actual residual differences, after the elimination

of those which are only apparent or fallacious—still retain three British species of *Pterichthys*, namely, *P. Milleri*, *P. productus*, and *P. oblongus*.

BOTHRIOLEPIS.

In my paper already quoted I included five British species, those being *B. major*, Agassiz; *B. hydrophilus*, Agassiz; *B. macrocephalus*, Egerton; and two others which I described as new, namely, *B. giganteus*, from Alves, near Elgin, and *B. obesus*, from the Jedburgh district.

The last of these, *B. obesus*, Traq., is a perfectly "good species," but I have seen reason to change my mind as regards *B. giganteus*. The characters by which I formerly distinguished it from *B. major*, Ag., were two, besides its large size, namely, the greater coarseness of the ornament on the plates, and the arm not being proportionally so long and slender as I supposed it to be in *B. major*. Here the examination of a considerable amount of additional material brings out two interesting facts.

1. The occurrence of smaller specimens in the Alves quarries, in which the ornament is finer than in the larger ones, and, in fact, indistinguishable from that of the plates of *B. major* from Scat Craig. This led me to compare the ornament in young and adult specimens of *B. Canadensis*, Whiteaves, with the result of finding that the coarseness of the sculpture of the plates increased with the size of the specimen. It is therefore not possible to distinguish *B. giganteus* from *B. major* by such a character.

2. Comparison of such elements as have hitherto occurred of the pectoral limb of *B. giganteus* from Alves, with the corresponding parts in *B. major* from Scat Craig, of which I have seen many since my paper of 1888 was written, fails to bring out any distinguishing peculiarity. Whence, then, did I derive the idea that this organ in *major* was peculiarly elongated? By assuming that the remains occurring at the Heads of Ayr, and which indeed show this peculiarity, belonged to the same species.

It is therefore not the species from Alves which is new, but that from the Heads of Ayr; so that while the for

must be incorporated with *B. major*, the latter must be separated from the northern species. To this form I now apply the term *leptochirus*.

B. leptochirus, n. sp. Plates of body rather thin, exposed surfaces covered with a rather delicate reticulo-tuberculate ornament. Arms slender, the articular plate of the upper arm having its greatest breadth contained 3½ times in its length, while the proportion in *B. major* is only 3 to 1. From the Upper Old Red Sandstone of Heads of Ayr, Hugh Miller Collection, Edinburgh Museum of Science and Art.

List of British Asterolepidæ.

Asterolepis maximus (Agassiz), Upper Old Red, Nairn.

Pterichthys Milleri, Agassiz, Lower Old Red, Moray Firth beds, Caithness (Achanarras), Orkney.

Pterichthys productus, Agassiz, same as above.

Pterichthys oblongus, Agassiz, Moray Firth beds.

Bothriolepis major (Agassiz), Upper Old Red, Scat Craig, Alves, and other localities in the neighbourhood of Elgin.

Bothriolepis hydrophilus, Agassiz, Upper Old Red, Dura Den.

Bothriolepis macrocephalus (Egerton), Upper Old Red, Farlow, Shropshire.

Bothriolepis obesus, Traquair, Upper Old Red, Jedburgh.

Bothriolepis leptochirus, Traquair, Upper Old Red, Heads of Ayr.

Microbrachius Dicki, Traquair, Lower Old Red, John o' Groats.

JOURNAL OF PROCEEDINGS.

SESSION CXX.

Wednesday, 19th November 1890.—GEORGE BROOK, Esq., F.R.S.E., Vice-President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: T. G. Laidlaw, Esq.; John Robert Williams, Esq., M.B., C.M.

An Opening Address was delivered by the retiring Vice-President, Dr G. S. Woodhead, F.R.S.E., on "Science and Physic."

Wednesday, 17th December 1890. Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: A. F. Bainbridge, Esq.; J. N. A. Laing, Esq., M.B., C.M.; W. A. B. Laing, Esq.; Alexander Nimmo, jun., Esq., M.A.; Henry A. Salvesen, Esq.

Reports were submitted by the Secretary, the Treasurer, and the Librarian.

The following Office-Bearers were elected:

President—RAMSAY H. TRAQUAIR, M.D., F.R.S.

Vice-Presidents—GEORGE BROOK, F.L.S., F.R.S.E.; JOHNSON SYMINGTON, M.D., F.R.S.E.; ROBERT KIDSTON, F.R.S.E., F.G.S.

Secretary—WILLIAM EVANS, F.R.S.E.

Assistant Secretary—JOHN GUNN, F.R.S.G.S.

Treasurer—GEORGE LISLE, C.A., F.F.A.

Librarian—J. ARTHUR THOMSON, M.A., F.R.S.E.

Councillors—David Hepburn, M.D.; A. B. Herbert; Rev. A. B. Morris; Professor Sir William Turner, LL.D., F.R.S.; W. Eagle Clark, F.L.S.; Professor James Geikie, D.C.L., F.R.S.; Robert C. Millar, C.A.; William Russell, M.D., F.R.C.P.E.; J. G. Goodchild, F.G.S., F.Z.S.; J. Berry Haycraft, M.D., F.R.S.E.; Lionel Hinxman, of H.M. Geological Survey; Thomas Scott, F.L.S.

The following communications were read:

1. "Summary of Recent Researches on the Structure and Development of Corals." By GEORGE BROOK, Esq., F.R.S.E.

2. "Some Notes on the Estimation of Raffinose." By P. CARADOC WILLIAMS, Esq.
3. "The Great Skua (*Stercorarius catarrhactes*); its status as a British Bird." By HAROLD RAEBURN, Esq.
4. Mr J. ARTHUR THOMSON, M.A., F.R.S.E., exhibited a Collection of Animals from Dominica.

Wednesday, 21st January 1891.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Alfred W. Hughes, Esq., M.B., F.R.C.S.E.; Young J. Pentland, Esq.; David Hunter, Esq., S.S.C.; John Stewart Norwell, Esq., B.Sc.

The following communications were read:

1. "The Great Grey Shrike (*Lanius excubitor*) as a Scottish Bird." By Rev. H. A. MACPHERSON, B.A., M.B.O.U.
2. "The Cultivation and Manufacture of Opium." By G. DALZIEL, Esq. (Communicated by the Assistant Secretary.)
3. "On Fish Spines, Recent and Fossil." By Dr R. H. TRAQUAIR, F.R.S.
4. Dr TRAQUAIR exhibited several Specimens of the Skulls of Mummy Cats from Egypt.
5. The SECRETARY, on behalf of Mr JAMES LUMSDEN of Arden, exhibited a Specimen of a Hybrid between the Capercaillie and Pheasant, shot at Arden on 8th November last.

Wednesday, 18th February 1891.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: John Scott Tait, Esq., C.A.

The following communications were read:

1. "On Robertson's Prevertebral Hæmolymph Glands." By Dr W. RUSSELL, F.R.C.P.E.
2. "Notes on a Collection of Petrels from Madeira, with Exhibition of Skins and Eggs." By J. J. DALGLEISH, Esq., M.B.O.U.
3. "Notes on the Pearl-Yielding Mollusca of the Persian Gulf." By ALEXANDER GALLETLY, Esq.
4. Mr THOMAS SCOTT, F.L.S., exhibited, with remarks, two Crustaceans (*Nepa edulis* and *Crangon fasciatus*) new to the Firth of Forth.

Wednesday, 18th March 1891.—ROBERT C. MILLAR, Esq., C.A., in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Fr. Bosse, Esq.; Richard Brown, Esq., C.A.

The following communications were read :

1. "Note on the Pineal Eye of *Lamna cornubica*, or Porbeagle Shark." By G. CARRINGTON PURVIS, Esq., M.D.
2. "On the Biological Examination of Water and Milk." By G. CARRINGTON PURVIS, Esq., M.D.
3. "Some further Notes on the Summer Birds of Shetland." By HAROLD RAEBURN, Esq.
4. "Notes on the Scottish Species of *Vertigo*, Recent and Fossil." By THOMAS SCOTT, Esq., F.L.S.
5. Mr THOMAS SCOTT, F.L.S., exhibited a small Collection of Scottish Echinoderms and Specimens of *Isocardia cor* from the Moray Firth.
6. Mr BARKER DUNCAN, W.S., read extracts from letters, dated 30th December and 31st January last, received from Mr GRAHAM KERR, the Naturalist attached to the Pilcomayo Expedition.

Wednesday, 15*th April* 1891.—ROBERT KIDSTON, Esq., F.R.S.E., Vice-President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: David Rankine, Esq., M.A.; John A. Shannon, Esq., M.A., F.S.Sc.

Messrs T. B. Sprague and R. C. Millar were appointed auditors of the current session's accounts.

The following communications were read :

1. "On the Climate of Strathpeffer Spa." By FORTESCUE FOX, Esq., M.D.
2. "On the Fructification of *Sphenophyllum trichomatosum*, Stur." By ROBERT KIDSTON, Esq., F.R.S.E.
3. "The Mammalian Fauna of the Edinburgh District." By WILLIAM EVANS, Esq., F.R.S.E.
4. "The Land and Fresh Water Crustacea of the District around Edinburgh." Part I. The *Amphipoda* and *Isopoda*. By THOMAS SCOTT, Esq., F.L.S.
5. Mr EVANS exhibited, on behalf of Mr CHARLES COOK, a Specimen of the Martin (*Martes sylvestris*) captured near Falkland, Fife, on 19th May 1870.

SESSION CXXI.

Wednesday, 18*th November* 1891.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: William Maxwell Tress, Esq.

An Opening Address was delivered by the retiring President, Dr R. H. TRAQUAIR, F.R.S., on "Some Points in connection with Natural History Museums."

Wednesday, 16th December 1891.—Dr SYMINGTON, F.R.S.E., Vice-President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: J. C. Mitchell, Esq., B.Sc.; Andrew G. Scott, Esq., M.A.

The usual Annual Reports were submitted by the Assistant Secretary (in the absence of the Secretary) and by the Treasurer.

The following Office-Bearers were elected:

President—Professor H. ALLEYNE NICHOLSON, F.G.S.

Vice-Presidents—JOHNSON SYMINGTON, M.D., F.R.S.E.; R. KIDSTON, F.R.S.E., F.G.S.; B. N. PEACH, F.R.S.E., F.G.S.

Secretary—WILLIAM EVANS, F.R.S.E.

Assistant Secretary—JOHN GUNN, F.R.S.G.S.

Treasurer—GEORGE LISLE, C.A., F.F.A.

Librarian—J. ARTHUR THOMSON, M.A., F.R.S.E.

Councillors—W. Eagle Clarke, F.L.S.; Professor James Geikie, D.C.L., F.R.S.; Robert C. Millar, C.A.; William Russell, M.D., F.R.C.P.E.; J. G. Goodchild, F.G.S., F.Z.S.; J. Berry Haycraft, M.D., F.R.S.E.; Lionel Hinxman, of H.M. Geological Survey; Thomas Scott, F.L.S.; James Bennie, of H.M. Geological Survey; George Brook, F.L.S., F.R.S.E.; R. W. Felkin, M.D., F.R.S.E.; R. H. Traquair, M.D., F.R.S.

The following communications were read:

1. "On the Occurrence of Risso's Dolphin (*Grampus griseus*) in the Shetland Seas." By Professor Sir WILLIAM TURNER, LL.D., F.R.S.
2. "On a Method of injecting the Canal of Petit in the Eye." By J. MUSGROVE, Esq., M.D.
3. "The Birds of the Deveron Valley." By J. HARVIE-BROWN, Esq., F.Z.S., F.R.S.E.
4. "Note on an Abnormal Specimen of the Thornback (*Raia clavata*)." By R. H. TRAQUAIR, Esq., M.D., F.R.S.
5. Mr RANKINE exhibited a Collection of Canadian Butterflies.

Wednesday, 20th January 1892.—Professor ALLEYNE NICHOLSON, F.G.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Edmond W. Carlier, Esq., M.D., B.Sc.; George S. Corstorphine, Esq., B.Sc.; John D. F. Gilchrist, Esq., M.A.; William A. Taylor, M.A.; Norman Wyld, Esq.

The Librarian submitted his Annual Report on the state of the Library.

The following communications were read:

1. "The Midlothian Esk and its Fish, with Exhibition of Specimens." By J. BARKER DUNCAN, Esq., W.S.
2. "Notes on some Carboniferous Lamellibranchs." By J. G. GOODCHILD, Esq., F.G.S., F.Z.S.

3. "Note on *Falco sacer*." By J. G. GOODCHILD, F.G.S., F.Z.S.
4. Mr ANDREW WILSON, L.D.S., submitted some remarks on an Illustration in *The Graphic* of 16th January, representing two Bull Giraffes fighting, and, at the same time, exhibited the skull of a Giraffe.

Wednesday, 17th February 1892.—Dr JOHNSON SYMINGTON, F.R.S.E., Vice-President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: J. Graham Kerr, Esq.

The following communications were read:

1. "A further Description of *Palæospondylus Gunnii*, Traq." By R. H. Traquair, Esq., M.D., F.R.S.
2. "The Patagonian Indian." By MIHANGEL AP IWAN, Esq., M.B.
3. "Notes on some Carboniferous Lamellibranchs." By J. G. GOODCHILD, Esq., F.G.S., F.Z.S.
4. Mr J. ARTHUR THOMSON exhibited Caterpillar Cases from South America.
5. Mr J. ARTHUR THOMSON exhibited a Fish of the genus *Hemirhamphus*, from the Indian Ocean.
6. Mr W. EVANS exhibited a Specimen of Daubenton's Bat, captured near Grantown, Strathspey, during last September.

Wednesday, 16th March 1892.—ROBERT KIDSTON, Esq., F.G.S., F.R.S.E., Vice-President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: James Stuart Thomson, Esq.

The following communications were read:

1. "A Critical Note on Recent Theories as to the Ascent of Sap." By NORMAN WYLD, Esq.
2. "The Raised Sea-Bottom of Fillyside: with List of Marine Organisms." By JAMES BENNIE, Esq.
3. "Sketch of the Climatology and Ethnology of Central Africa." By R. W. FELKIN, Esq., M.D., F.R.S.E.
4. Mr EVANS exhibited a Female Specimen of the Great Bustard, shot in February last on the Island of Stronsay, Orkney.
5. Mr EVANS exhibited a Female Specimen of the Common Bittern, killed near Moffat in January last.

Wednesday, 20th April 1892.—Professor ALLEYNE NICHOLSON, F.G.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: John Roche Dakyns, Esq., M.A.; Hugh Lewis Hughes, Esq.

The following communications were read:

1. "On two of Lindley and Hutton's Type Specimens—(1) *Rhacopteris d*
L. and H. sp.; (2) *Sphenopteris polyphylla*, L. and H." By Ro
KIDSTON, Esq., F.G.S.

2. "On a new Species of *Bythotrephis* from the Lower Carbonifero
Lancashire." By ROBERT KIDSTON, Esq., F.G.S.

3. Mr GOODCHILD, on behalf of Mr EAGLE CLARKE, exhibited, with rem
a Specimen of the Hoatzin.

4. "On the Moulting of Birds of Prey." By J. G. GOODCHILD, Esq., F.
F.Z.S.

5. "On the Facts of Sex in Relation to Metabolism." By J. AR
THOMSON, Esq., M.A., F.R.S.E.; and NORMAN WYLD, Esq.

Mr Sprague and Mr Millar were re-elected auditors.

LIST OF SOCIETIES WHICH RECEIVE THE SOCIETY'S "PROCEEDINGS."

Those Institutions from which Publications have been received in return are indicated by an asterisk.

ENGLAND.

BIRMINGHAM,	*Philosophical Society, King Edward's Grammar School.
Do.	*Natural History Society, Sir Josiah Mason's College.
CAMBRIDGE,	*Philosophical Society.
Do.	University Library.
CIRENCESTER,	*Editor of the *Argricultural Students' Gazette.*
DURHAM,	University Library.
HALIFAX,	*Yorkshire Geological and Polytechnic Society.
LEEDS,	*The Conchological Society of Great Britain and Ireland.
LIVERPOOL,	*Biological Society, University College.
Do.	*Literary and Philosophical Society.
Do.	*Engineering Society, Royal Institution.
LONDON,	British Museum Library.
Do.	*British (Natural History) Museum, South Kensington.
Do.	*Royal Society, Burlington House, Piccadilly, W.
Do.	Chemical Society, Burlington House, Piccadilly, W.
Do.	*Geological Society, Burlington House, Piccadilly, W.
Do.	*Linnean Society, Burlington House, Piccadilly, W.
Do.	*Royal Microscopical Society, King's College.
Do.	Museum of Economic Geology, Jermyn Street.
Do.	Editor of *Nature*, 29 Bedford Street, Covent Garden.
Do.	*Zoological Society, Hanover Square.
Do.	*Geologists' Association, University College, W.C.
MANCHESTER,	*Geological Society, 36 George Street.
Do.	*Literary and Philosophical Society, 36 George Street.
Do.	*The Owens College.
NORWICH,	*Norfolk and Norwich Naturalists' Society, The Museum.
OXFORD,	Bodleian Library.
TRURO,	*Royal Institution of Cornwall.
WATFORD,	*Hertfordshire Natural History Society and Field Club.

SCOTLAND.

ABERDEEN,	University Library.
COCKBURNSPATH,	*Berwickshire Naturalists' Field Club, Old Cambus.
EDINBURGH,	Advocates' Library.
Do.	University Library.
Do.	*Royal Society.

EDINBURGH, . .	Royal Medical Society.
Do. . .	*Royal Scottish Society of Arts.
Do. . .	*Royal Scottish Geographical Society.
Do. . .	*Botanical Society.
Do. . .	*Highland and Agricultural Society.
Do. . .	*Geological Society.
GLASGOW, . .	*Philosophical Society.
Do. . .	*Natural History Society.
Do. . .	*Geological Society.
Do. . .	University Library.
PERTH, . .	Perthshire Society of Natural History.
ST ANDREWS, . .	University Library.

IRELAND.

BELFAST, . .	Natural History and Philosophical Society.
DUBLIN, . .	*Royal Irish Academy.
Do. . .	*Royal Dublin Society.
Do. . .	*Royal Geological Society of Ireland.

HOLLAND.

AMSTERDAM, . .	*De Koninklijke Akademie van Wetenschappen.
LEYDEN, . .	*Museum van Naturlijke Histoire.
UTRECHT, . .	Provinciaal Genootschap au Kunsten en Wetenschappen.

SWITZERLAND.

BASLE, . . .	*Die Naturforschende Gesellschaft.
BERN, . . .	*Allgemeine Schweizerische Gesellschaft für die gesammten Naturwissenschaften.
Do. . . .	*Die Naturforschende Gesellschaft.
GENEVA, . .	*Société de Physique et d'Histoire Naturelle.
NEUFCHATEL, . .	*Société des Sciences Naturelles.
ZÜRICH, . . .	*Die Naturforschende Gesellschaft.

GERMANY.

BERLIN, . . .	*Königliche Akademie der Wissenschaften.
Do. . . .	*Deutsche Geologische Gesellschaft.
Do. . . .	*Gesellschaft Naturforschender Freunde.
BONN, . . .	*Naturhistorischer Verein der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.
BREMEN, . .	*Verein für Naturwissenchaft.
BRESLAU, . .	*Schlesische Gesellschaft für Vaterländische Cultur.
BRUNSWICK, . .	*Naturwissenschaftlicher Verein.
DRESDEN, . .	Königliche Sammlungen für Kunst und Wissenschaft.
Do. . .	*Der Verein für Erdkunde.
ELBERFELD, . .	*Naturwissenschaftlicher Verein.
ERLANGEN, . .	University Library.
FRANKFORD-ON-MAIN,	*Senckenbergische Naturforschende Gesellschaft.
Do.	*Deutsche Malakozoologische Gesellschaft, Dr Kobelt, Schwanheim.
FREIBURG, i. B., .	Die Naturforschende Gesellschaft.
GÖTTINGEN, . .	*Königliche Gesellschaft der Wissenschaften.
HALLE, . . .	*Kaiserliche Akademie der Naturforscher.

JENA, . . .	*Medicinisch-naturwissenschaftliche Gesellschaft.
LEIPZIG, . . .	*Königliche Sächsische Gesellschaft der Wissenschaften.
Do. . . .	Naturforschende Gesellschaft.
Do. . . .	Editor of the *Zoologischer Anzeiger*.
MUNICH, . .	*Königliche Baierische Akademie der Wissenschaften.
STUTTGART, . .	*Verein für Vaterländische Cultur in Württemberg.
WÜRZBURG, . .	*Physikalisch-medicinische Gesellschaft.

AUSTRIA.

AGRAM, . . .	*Societas Croatica Historico-naturalis.
HERMANNSTADT, .	*Siebenbürgischer Verein für Naturwissenschaft.
PRAGUE, . .	Königliche-böhmische Gesellschaft der Wissenschaften.
TRIESTE, . .	Società Adriatica di Scienze Naturali.
VIENNA, . .	*K. k. zoologisch-botanische Gesellschaft.
Do. . .	*K. k. Naturhistorisches Hof-Museum.

ITALY.

BOLOGNA, . .	*Accademia delle Scienze dell' Istituto.
MILAN, . . .	*Reale Istituto Lombardo di Scienze, Lettere ed Arti.
Do. . . .	Società Italiana di Scienze Naturali.
MODENA, . .	Società dei Naturalisti.
NAPLES, . . .	Editor of the *Zoologischer Jahresbericht*, Zoological Station.
PADUA, . . .	*Società Veneto-Trentina di Scienze Naturali residente in Padova.
ROME, . . .	*Reale Accademia dei Lincei.
TURIN, . . .	*Reale Accademia delle Scienze.

SPAIN.

MADRID, . .	*Real Academia de Ciencias exactas, fisicas e naturales.
Do. . .	Sociedad española de Historia natural.

PORTUGAL.

COIMBRA, . .	Bibliothèque de l'Université.
LISBON, . . .	*Academia Real das Sciencias.

FRANCE.

BORDEAUX, . .	La Société Linnéenne.
CAEN, . . .	Société Linnéenne de Normandie.
CHERBOURG, . .	*Société Nationale des Sciences Naturelles.
PARIS, . . .	*Académie des Sciences de l'Institut.
Do. . . .	*Société Géologique de France, Rue des grands Augustins, 7.
Do. . . .	*Société Zoologique de France, Rue des grands Augustins, 7.
Do. . . .	Société de Biologie.
Do. . . .	École des Mines.

BELGIUM.

BRUSSELS, . .	*Académie Royale des Sciences, des Lettres, et des beaux Arts.
Do. . .	*Société Royale Malacologique de Belgique.
Do. . .	*Société Belge de Microscopie.

SCANDINAVIA.

Bergen, . . .	*The Museum.
Christiania, . .	*Den Naturhistoriske Forening.
Do. . .	Universitets Bibliothek.
Copenhagen, . .	*Kongelige Danske Videnskabernes Selskab.
Do. . .	*Naturhistoriske Forening.
Stockholm, . .	*Kongliga Svenska Vetenskaps-Akademie.
Upsala, . . .	*Kongliga Vetenskaps-Societeten.
Do. . . .	*Observatoire Météorologique.

RUSSIA.

Dorpat, . . .	*Naturforscher Gesellschaft.
Kiev, . . .	*Natural History Society.
Moscow, . .	*Société Impériale des Naturalistes.
St Petersburg, .	*Académie Impériale des Sciences.
Do. .	*Imperial Botanic Garden.

AMERICA.

United States.

Albany, N.Y., .	*New York State Library.
Baltimore, . .	*Johns-Hopkins University Library.
Boston, . . .	*American Academy of Arts and Sciences.
Do. . . .	*Society of Natural History.
Brookville, Ind., .	*Brookville Society of Natural History.
Cambridge, Mass.,	*Harvard University Library.
Do.	*Museum of Comparative Zoology.
Chicago, . .	*Academy of Sciences.
Cincinnati, . .	*Society of Natural History.
Newhaven, Conn.,	*Connecticut Academy of Arts and Sciences.
Do.	Yale College Library.
New York, . .	*New York Academy of Sciences.
Ohio, . . .	*Mechanics Institute.
Philadelphia, .	*Academy of Natural Sciences.
Do. .	*Wagner Free Institute.
San Francisco, .	*California Academy of Sciences.
St Louis, . .	*Academy of Sciences.
Washington, .	*Smithsonian Institute.
Do. . .	Philosophical Society.
Do. . .	*United States National Museum.
Do. . .	*United States Geological Survey.
Do. . .	*United States Commissioner of Fish and Fisheries.

Mexico.

Mexico, . . .	*Ministerio de Fomento de la Republica, Osservatorio Meteorologico.
Do. . . .	*Sociedad Cientifica, "Antonio Alzate," Osservatorio Meteorologico Central.

Canada.

Hamilton, . .	*The Hamilton Association.
Kingston, . .	*Queen's University.

MANITOBA, . .	*Historical and Scientific Society, Winnipeg.
MONTREAL, . .	*The Natural History Society.
OTTAWA, . .	*Canadian Geological Survey.
Do. . .	*Royal Society of Canada.
TORONTO, . .	*The Canadian Institute.

NOVA SCOTIA.

HALIFAX, . .	*Nova Scotia Institute of Natural Science.

BRAZIL.

RIO DE JANEIRO, .	Museu Nacional.

AFRICA.

CAPE TOWN, . .	South African Philosophical Society.

ASIA.

BATAVIA, . . .	*Koninklijke Natuurkundige Vereeniging in Nederlandsch Indie.
CALCUTTA, . . .	Royal Asiatic Society of Bengal.
SHANGHAI, . .	*China Branch of the Asiatic Society.
TOKIO, JAPAN, . .	*Imperial University of Japan.

AUSTRALASIA.

ADELAIDE, . .	*Royal Society of South Australia.
MELBOURNE, . .	*Royal Society of Victoria.
SYDNEY, . . .	*Royal Society of New South Wales.
Do. . . .	*The Australian Museum.
Do. . . .	*Linnean Society of New South Wales.
WELLINGTON, . .	*New Zealand Institute.

LIST OF FELLOWS,

As at 31st October 1892.

*Those marked * are Life Members.*

Date of Election.	
1856.	*Anderson, J., M.D., LL.D., F.R.SS. L. & E., F.L.S., F.Z.S., F.A.S., 71 Harrington Gardens, London, S.W.
1872.	Anderson, James, 135 Mayfield Road.
1880.	Anderson, J. M., S.S.C., Strathearn Lodge, 1 Strathearn Place.
1888.	Ap Iwan, Mihangel, M.B., C.M., Independent College, Bala, N. Wales.
1884.	Armitage, J. A., B.A., 15 Waterloo Road South, Wolverhampton.
1884.	Baildon, Henry Bellyse, B.A., Duncliffe, Murrayfield.
1884.	Baily, Edwin, M.B., C.M., Victoria Crescent, Oban.
1890.	Bainbridge, A. F., 18 Clyde Street.
1890.	Bainbridge, Frank Gascoigne, c/o Agent, African Lakes Company, Quilimane, Africa.
1886.	Ballantyne, John W., M.D., F.R.C.P., 24 Melville Street.
1885.	Barbour, A. H. F., M.A., B.Sc., M.D., 24 Melville Street.
1885.	Barrett, W. H., M.B., C.M., Dunmore House, Strone, Argyleshire.
1886.	Barry, J. Houston, 53 George Street.
1884.	Beaumont, Alfred, 153 Hither Green Lane, Lewisham, Kent.
1880.	*Beddard, Frank E., M.A., F.R.S., Zoological Gardens, London.
1875.	Bennie, James, Geological Survey, George IV. Bridge.
1881.	*Berry, W., of Tayfield, Newport, Fife.
1880.	Bird, George, 24 Queen Street.
1891.	Bosse, Fr., Edinburgh Geographical Institute, Park Road.
1883.	Bowie, A. F., 16 Duncan Street, Newington.
1885.	Brook, George, F.L.S., F.R.S.E., The University.
1876.	Brown, J. A. Harvie, F.Z.S., F.R.S.E., Dunipace House, Larbert.
1885.	Brown, J. Macdonald, M.A., F.R.C.S., Apsley Lodge, Grange.
1860.	*Brown, R., M.A., Ph.D., F.L.S., F.R.G.S., Ferslev, Rydal Road, Streatham, London, S.W.
1891.	Brown, Richard, C.A., 23 St Andrew Square.
1876.	*Bruce, W. P., Kinleith Mill, Currie.
1882.	Bryson, Wm. A., Consulting Electrical Engineer, 5 Bentick Street, Kelvingrove, Glasgow.
1885.	Buckley, T. E., B.A., F.Z.S., Rossal, Inverness.
1885.	Burt, Robert F., 124 Stroud Green Road, Finsbury Park, London, N.
1887.	Calderwood, W. L., Laboratory, Citadel Hill, Plymouth.

Date of Election.

1886. Campbell, Andrew, Burmah Oil Company, Rangoon.
1892. Carlier, Edmond W., B.Sc., M.D., Physiological Laboratory, The University.
1876. *Carmichael, Sir T. D. Gibson, Bart., Castlecraig, Dolphinton.
1858. Carruthers, W., F.R.S., British Museum, London.
1887. Clarke, E. Wearne, B.Sc., M.B., C.M., Kilhlean House, Chesterfield.
1888. Clarke, W. Eagle, F.L.S., 86 Braid Road.
1888. Coghill, P. D., Royal Veterinary College, Camden Town, London.
1881. Cook, C., W.S., 11 Great King Street.
1887. *Corke, H. C., F.R.S., 178 High Street, Southampton.
1892. Corstorphine, George S., B.Sc., 19 Henderson Terrace.
Crawford, W. C., M.A., Lockharton Gardens, Slateford.
1850. Crole, D., 1 Royal Circus.
1892. Dakyns, John Roche, M.A., Geological Survey, George IV. Bridge.
1877. *Dalgleish, J. J., 1 Rutland Square.
1885. Dendy, Arthur, B.Sc., c/o Dulau & Co., 37 Soho Square, London, W.
1883. Dickson, G. W., M.B., M.A., Dunkeld.
1889. Drieberg, Principal C., Agricultural College, Colombo, Ceylon.
1880. Drummond, W., S.S.C., 4 Learmonth Terrace.
1886. Duncan, James, 8 Ainslie Place.
1885. Duncan, J. Barker, W.S., 6 Hill Street.
1883. Dunn, Malcolm, Palace Gardens, Dalkeith.
1864. *Duns, Professor, D.D., F.R.S.E., 14 Greenhill Place.
1888. Edington, Alexander, M.B., C.M., Bacteriological Laboratory, Cape Town, South Africa.
1863. *Edmonston, A., Delta Cottage, Pitlochry.
1889. Elsworth, R. C., M.B., C.M., 10 Lauriston Park.
1880. Erskine, W., Oaklands, Trinity Road.
1880. Evans, Wm., F.F.A., F.R.S.E., 18a Morningside Park.
1883. Ewart, Professor Cossar, M.D., The University.
1890. Felkin, Robert W., M.D., F.R.S.E., 20 Alva Street.
1884. Fenton, Gerald H., Bellary, Madras, India.
1882. Ferguson, J., 18 Clyde Street.
1884. *Ferguson, James A. E., M.B., Public Lunatic Asylum, Berbice, British Guiana.
1885. Ferguson, James Haig, M.D., F.R.C.P.E., 25 Rutland Street.
1887. Ferguson, R. M., Ph.D., 5 Learmonth Terrace.
1889. Fox, Fortescue, M.D., Strathpeffer Spa.
1887. Fulton, T. Wemyss, M.B., C.M., 23 Royal Crescent.
1877. Galletly, A., Museum of Science and Art.
1884. Geikie, Professor James, D.C.L., F.R.S., The University.
1883. Gemmill, Wm., M.D., Albert Villa, Beith.
1883. Gibson, E., 1 Eglinton Crescent.
1881. Gibson, J., Ph.D., F.R.S.E., 15 Hartington Gardens.
1892. Gilchrist, John D. F., M.A., B.Sc., Carvenom, Anstruther.
1880. Glover, J., S.S.C., 1 Hill Street.
1889. Goodchild, J. G., F.Z.S., F.G.S., Museum of Science and Art.
1877. Grieve, S., 21 Queen's Crescent.

Date of Election.

1886. Grieve, Symington, 11 Lauder Road.
1887. Gunn, John, F.R.S.G.S., 4 Parkside Terrace, *Acting Secretary.*
1887. Hailes, Dr Clement, Clifton, Bristol.
1883. Hallen, J. H. B., Pebworth, near Stratford-on-Avon.
1881. Hamilton, R., Trinity Lodge, Trinity.
1889. Haycraft, J. Berry, M.D., F.R.S.E.
1883. Henderson, Professor, F.L.S., Christian College, Madras.
1883. Hepburn, David, M.D., The University.
1879. Herdman, Professor, F.R.S.E., University College, Liverpool.
1884. Hinxman, Lionel, Geological Survey, George IV. Bridge.
1882. Hogg, A., 94 George Street.
1886. Horn, Wm., Advocate, Woodcote Park, Blackshiels, Midlothian.
1878. Horne, J., F.G.S., Geological Survey, George IV. Bridge.
1886. Howden, Robert, M.B., C.M., University of Durham College of Medicine, Newcastle-on-Tyne.
1884. Howell, Henry H., Geological Survey, George IV. Bridge.
1883. Hoyle, W. E., M.A., F.R.S.E., The Owens College, Manchester.
1891. Hughes, Alfred W., M.B., F.R.C.S.E., Woodside, Musselburgh.
1892. Hughes, Hugh Lewis, Surgeon, Dowlais, South Wales.
1891. Hunter, David, S.S.C., 29 Dundas Street.
1880. Hunter, James, F.R.C.S.E., F.R.A.S., Rosetta, Liberton.
1874. Hunter, John, F.C.S., Minto House, Chambers Street.
1878. *Hunter, J. R. S., LL.D., Daleville, Braidwood, Lanarkshire.
1885. Hunter, Wm., M.B., C.M., St John's College, Cambridge.
1888. Hutchinson, Alfred, B.Sc., The Leys, Cambridge.
1850. *Jenner, Charles, F.R.S.E., Easter Duddingston Lodge, Portobello.
1877. Joass, Edward C., Standard Life Insurance Co., 3 George Street.
1880. Johnstone, J. A.
1886. Kelso, J. E. H., M.B., C.M., Downlee, St Andrews Road, Elmgrove, Southsea, Hants.
1881. Kemp, D. W., Ivy Lodge, Trinity.
1869. *Kennedy, Rev. J., M.A., B.D., 9 Hartington Place.
1892. Kerr, J. Graham, Christ's College, Cambridge.
1878. Kidston, Robert, F.G.S., F.R.S., Victoria Place, Stirling.
Kilpatrick, H. G., 104 South Bridge.
1890. Laidlaw, T. G., 8 Morningside Road.
1890. Laing, J. H. A., M.B., C.M., 11 Melville Street,
1880. Laughton, W., Don Cottage, Gordon's Mills, near Aberdeen.
1884. Laurie, Malcolm, King's College, Cambridge.
1879. Leslie, Dr, Falkirk.
1884. Lindsay, R., Curator, Royal Botanic Garden.
1886. Lisle, George, C.A., F.F.A., 5 N. St David Street, *Treasurer.*
1861. Logan, A., Register House.
1881. Lumsden, J., of Arden, Alexandria, N.B.
1855. *Macadam, Stevenson, Ph.D., Surgeons' Hall.
1885. Macadam, W. Ivison, F.C.S., F.R.S.E., Surgeons' Hall.
1881. Macalpine, A. N., B.Sc., Minto House.
Macconochie, A., Geological Survey, George IV. Bridge.

Date of Election.

1886. M'Cracken, Professor, Crewe.
1882. *M'Donald, L. M., of Skaebost, Skye.
1885. Macgregor, John, L.R.C.P., Rashcliff, Huddersfield.
1889. Mackie, John, 479 St Vincent Street, Glasgow.
1883. M'Laren, Dr J., Wingate, Co. Dublin.
1878. Maclauchlan, J., Albert Institute, Dundee.
1887. MacMunn, Charles A., M.A., M.D., Oakleigh, Wolverhampton.
1882. M'Vean, C. A., C.E., Killiemore House, Pennyghael, Oban.
1886. MacWatt, R. Charles, M.A., M.B.
1880. Marsden, R. S., D.Sc., Town Hall, Birkenhead.
1885. Melle, George James M'Carthy, M.B., C.M., Robertson, Cape Colony.
1873. Millar, R. K., 13 Lennox Street, Eton Terrace.
1889. Millar, Robert C., C.A., 8 Broughton Place.
1881. Miller, Hugh, F.R.S.E., Geological Survey, George IV. Bridge.
1891. Mitchell, J. C., B.Sc., West End Cottage, Gilmerton.
1883. Mitchell, Robert, 14 Marchhall Road.
1876. Moffat, A., 9 Wilfred Terrace.
1884. Morris, Rev. A. B., F.L.S., 18 Eildon Street.
1890. Mossman, R. C., F.R.Met.S., 10 Blacket Place.
1880. Muirhead, G., F.R.S.E., Mains of Haddo, Aberdeen.
1882. Murdoch, J. B., Capelrig, Mearns, Renfrewshire.
1881. Murdoch, T. Burn, M.B., C.M., 31 Morningside Road.
1874. Murray, D. R., M.B., C.M., 41 Albany Street, Leith.
1877. Murray, John, Ph.D., LL.D., F.L.S., F.R.S.E., Broomfield, Davidson's Mains.
1884. Murray, R. Milne, M.A., M.B., 10 Hope Street.
1889. Musgrove, James, M.D., 10 Lauriston Park.
1880. Nicholson, Professor H. Alleyne, D.Sc., F.L.S., F.G.S., Aberdeen, *President.*
1890. Nimmo, Alexander, jun., Westbank, Falkirk.
1887. Norman, Rev. Canon, D.C.L., Burnmoor Rectory, Fence Houses.
1891. Norwell, John Stewart, B.Sc., 21 Warrender Park Terrace.
1887. Oliver, John S., 12 Greenhill Park.
1886. *Panton, George A., F.R.S.E., 73 Westfield Road, Edgbaston, Birmingham.
1870. Peach, B. N., F.R.S., Geological Survey, George IV. Bridge.
1891. Pentland, Young J., 9 Hope Park Terrace.
1888. Porter, George, 14 Thirlstane Road.
1883. Pullar, Alfred, M.D., Leonard Bank, Beulah Hill, Upper Norwood, London, S.E.
1879. Pullar, R. D., Ochil, Perth.
1889. Purvis, G. Carrington, M.D., 43 Barclay Place.
1885. Raeburn, Harold, 49 Manor Place.
1881. *Ramsay, Major Wardlaw, Tillicoultry House, Tillicoultry.
1890. Rankine, David, M.A., 21 Charles Street.
1881. Richardson, T., 5 North-West Circus Place.
1886. Roberton, E., M.B., C.M., M.R.C.S.
1861. *Robertson, T., c/o J. Nisbet & Co., 21 Berners Street London, W.

Date of Election.

1883. Robertson, W. W., Wardie Bank.
1890. Rogerson, John J., LL.D., Merchiston Castle.
1880. Rowland, Professor, M.A., M.D., The University, Salem, Oregon, U.S.A.
1887. Russell, William, M.D., F.R.C.P.E., 46 Albany Street.
1890. Salvesen, Henry A., Blair Bank, Polmont.
1890. Saxton, Professor, M.R.C.V.S., Colonial College, Hollesley Bay, Suffolk.
1891. Scott, Andrew G., M.A., 27 Kilmaurs Road.
1889. Scott, Thomas, F.L.S., 14 Lorne Street, Leith Walk.
1884. Scott, W. Sawers, M.D.
1886. Service, Robert, Laurieknowe, Maxwelltown, Dumfries.
1886. Shand, Alexander, Physical Laboratory, The University.
1891. Shannon, John A., M.A., F.S.Sc., 11 Melville Terrace.
1883. Sherriff, George, Woodcroft, Larbert.
1882. Simpson, James, Anatomical Museum, The University.
1869. *Skirving, R. Scot-, 29 Drummond Place.
1877. Smith, J. A. J., F.R.C.S.E., Kimberley, South Africa.
1886. Somerville, Professor Wm., B.Sc., F.R.S.E., D.Œ., F.L.S., Durham College of Science, Newcastle-on-Tyne.
1880. Sprague, T. Bond, M.A., F.R.S.E., 29 Buckingham Terrace.
1880. Stark, A. C., M.B., C.M., The Cottage, Whiteparish, near Salisbury.
1882. Stewart, R., S.S.C., 7 E. Claremont Street.
1882. Stirling, J., of Garden, Stirlingshire.
1888. Stump, E. C., 16 Herbert Street, Moss Side, Manchester.
Surenne, D. J., 6 Warriston Crescent.
1882. Swinburne, J., 21 Saumarez Street, St Peter's Port, Guernsey.
1879. Symington, J., M.D., F.R.S.E., 2 Greenhill Park.
1891. Tait, John Scott, C.A., 67 George Street.
1881. Tanner, T. S., 104b Mount Street, Berkeley Square, London, W.
1851. *Taylor, A., 11 Lutton Place.
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1874. *Thomson, R., LL.B., 6 Shandwick Place.
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1882. Wallace, Professor R., The University.
1887. Wallace, Samuel W., Director, Agricultural College, Ghizeh, Cairo, Egypt.

Date of Election.

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1884. Watson, Wm., M.D., Lockarton, Slateford.
1884. Webster, A. D., M.D., 20 Newington Road.
1887. Webster, Hugh A., F.R.S.E., The University.
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1888. White, Philip J., M.B., C.M., University College, Bangor.
1878. White, T., S.S.C., 114 George Street.
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1890. Williams, John Robert, M.B., C.M., Menai View, North Road, Carnarvon.
1886. Williams, P. Caradoc.
1885. Williams, W. Owen, M.R.C.V.S., New Veterinary College.
Wilson, A., L.D.S., 2 N. Charlotte Street.
1885. Wilson, Alfred C., F.C.S., Chemical Laboratory, Borough Hall, Stockton-on-Tees.
1890. Wilson, Wm., M.A., Physical Laboratory, Merchant Venturers' School, Bristol.
1886. Wood, George E., M.B., C.M., Baileyfield, Portobello.
1883. Woodhead, G. S., M.D., F.R.S.E., Beverley, Nightingale Lane, Balham, London, S.W.
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1881. Young, F. W., F.C.S., High School, Dundee.
1882. Young, J., 64 Hereford Road, Bayswater, London, S.W.

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1857. Javet, Charles, Paris.
1857. Kraatz, G., Berlin.
1886. Lacaze-Duthiers, H. de, Paris.
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1869. Lütken, Chr., University Museum, Copenhagen.
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1888. Vines, Sydney H., M.A., F.R.S., Christ's College, Cambridge.

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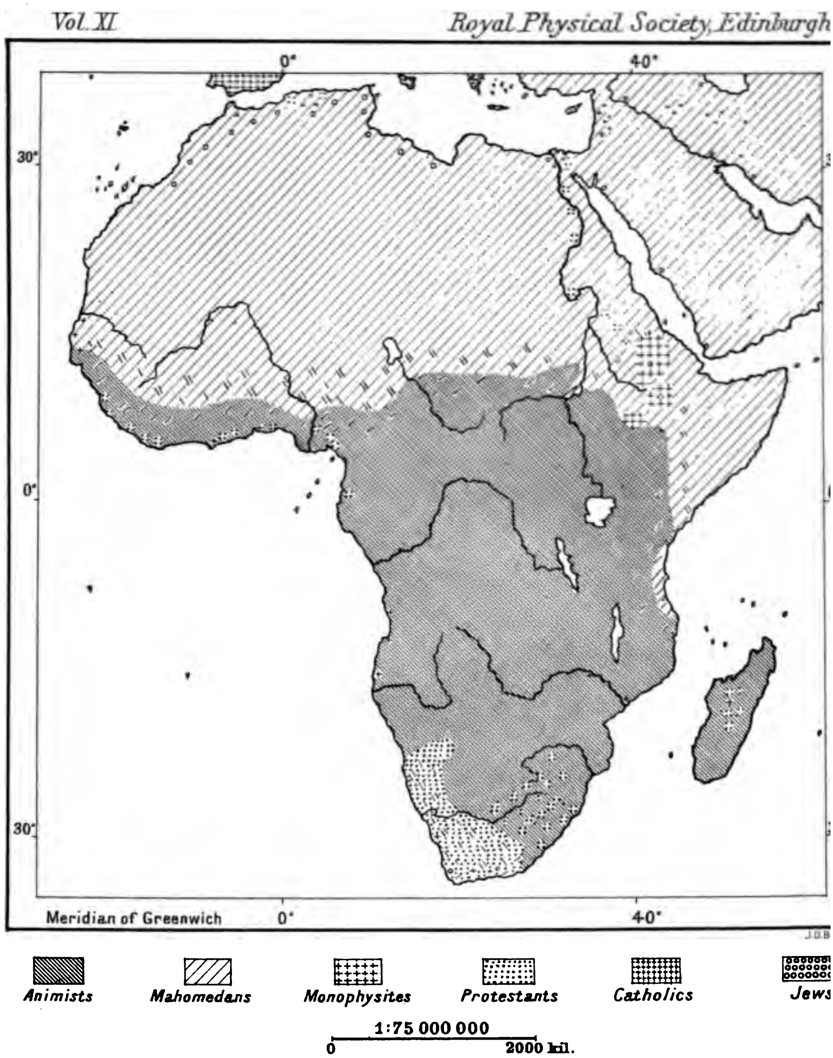

RACES & RELIGIONS, *after Reclus*.

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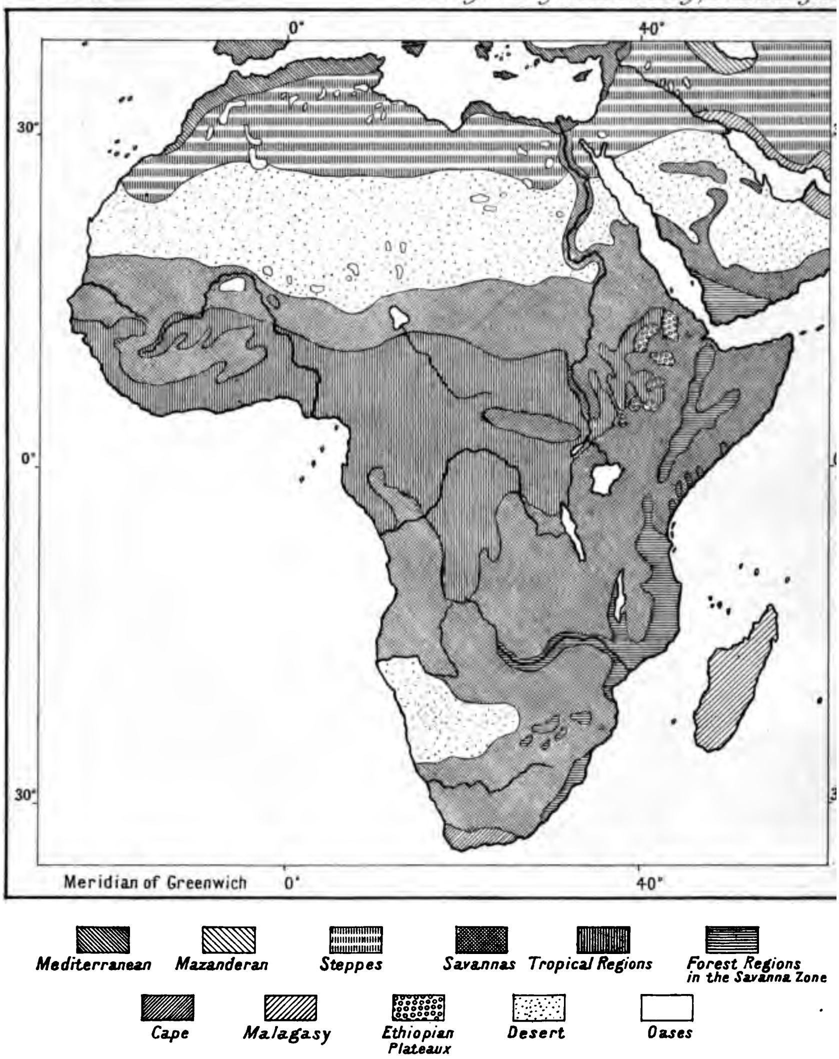

CULTIVATION, *after Reclus.*

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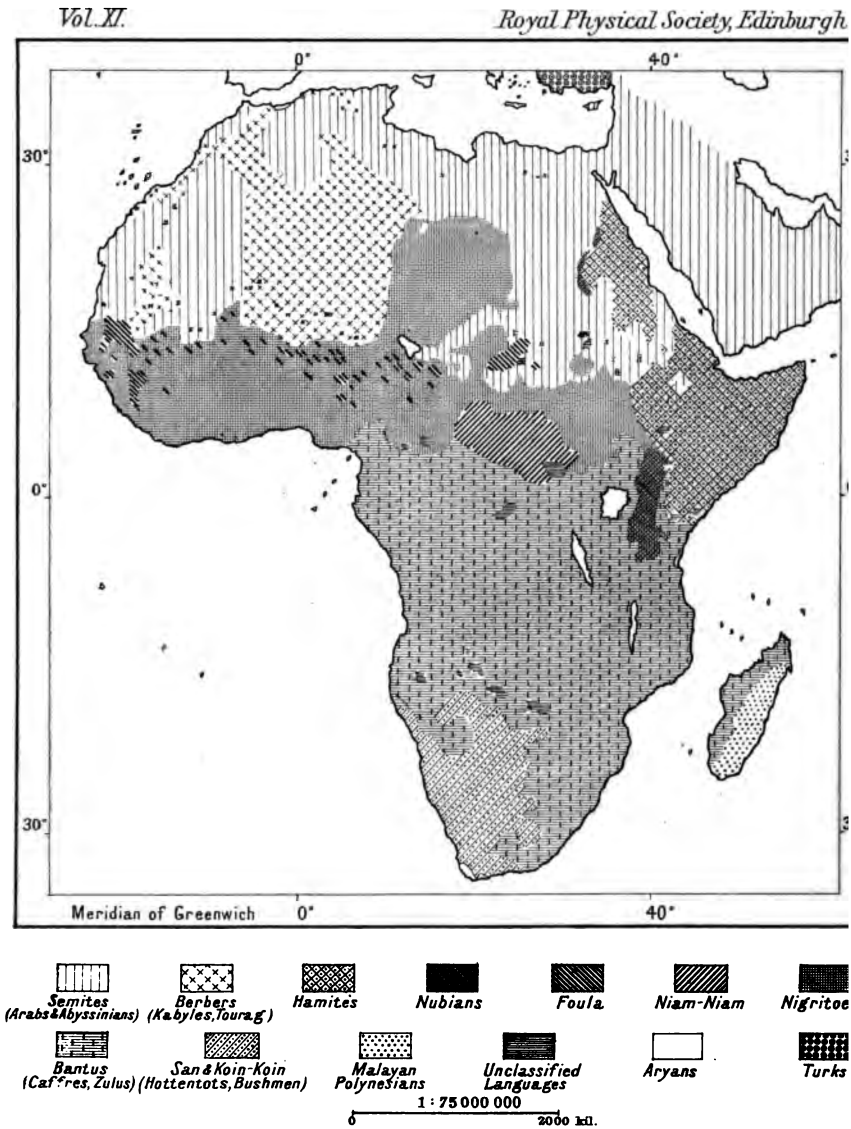

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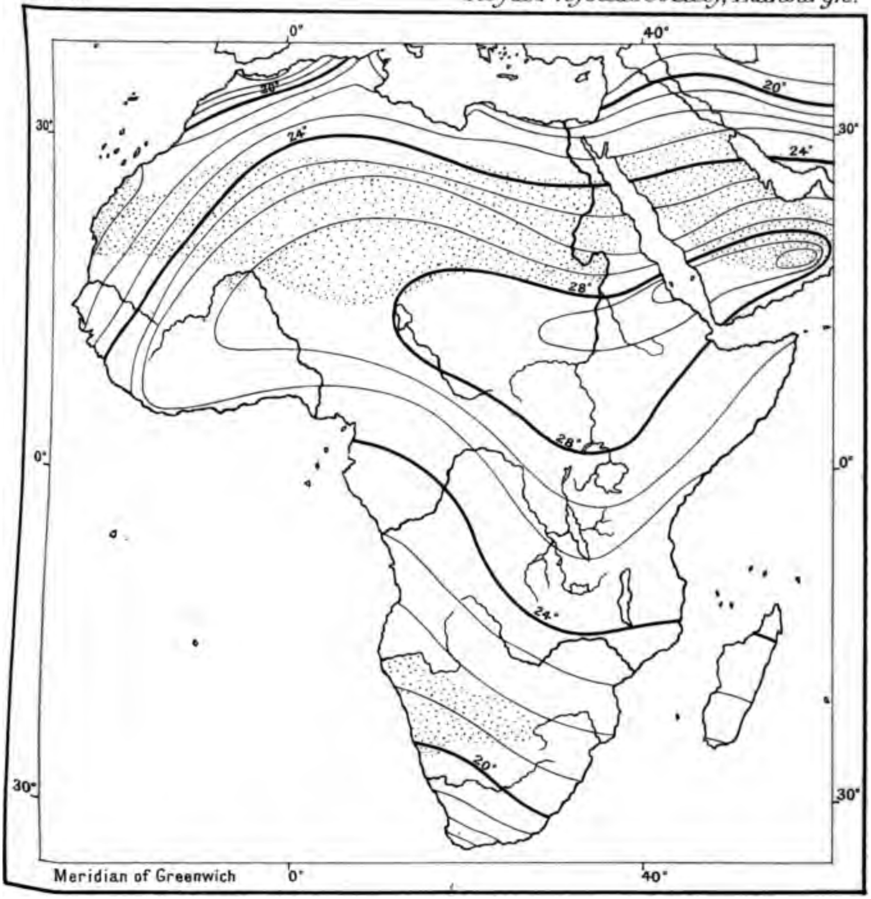

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TEMPERATURE, *after Reclus.*

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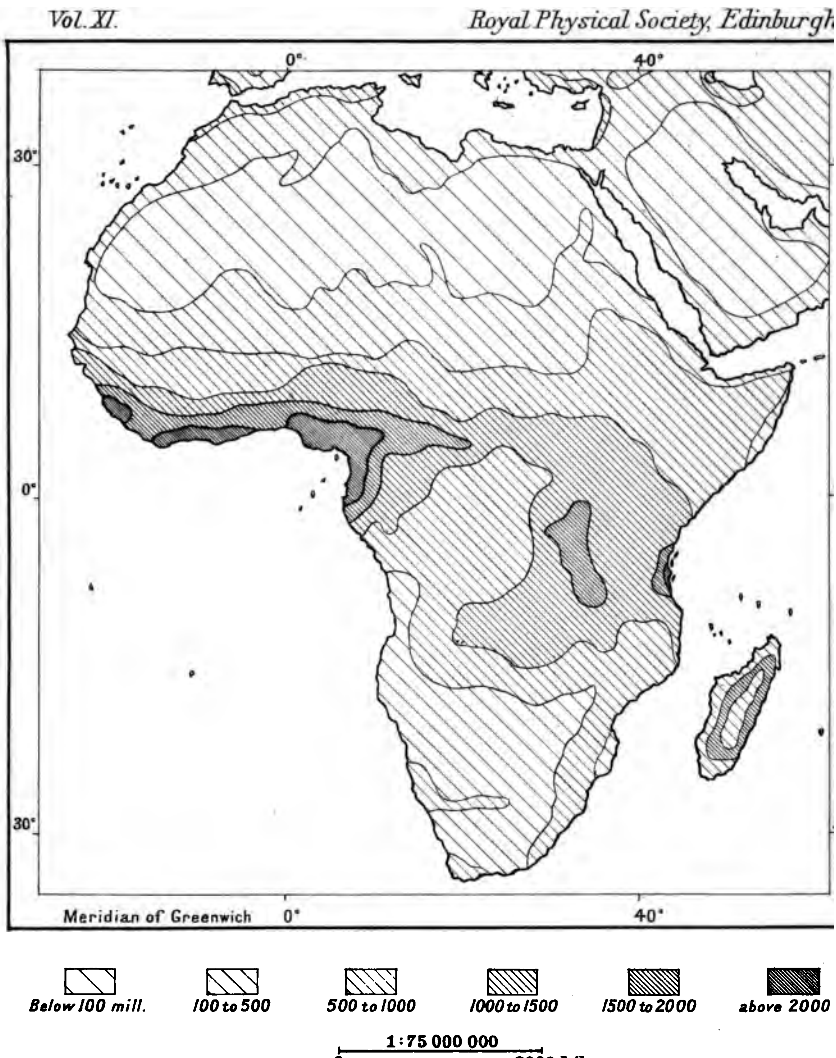

RAINFALL, *after Reclus*.

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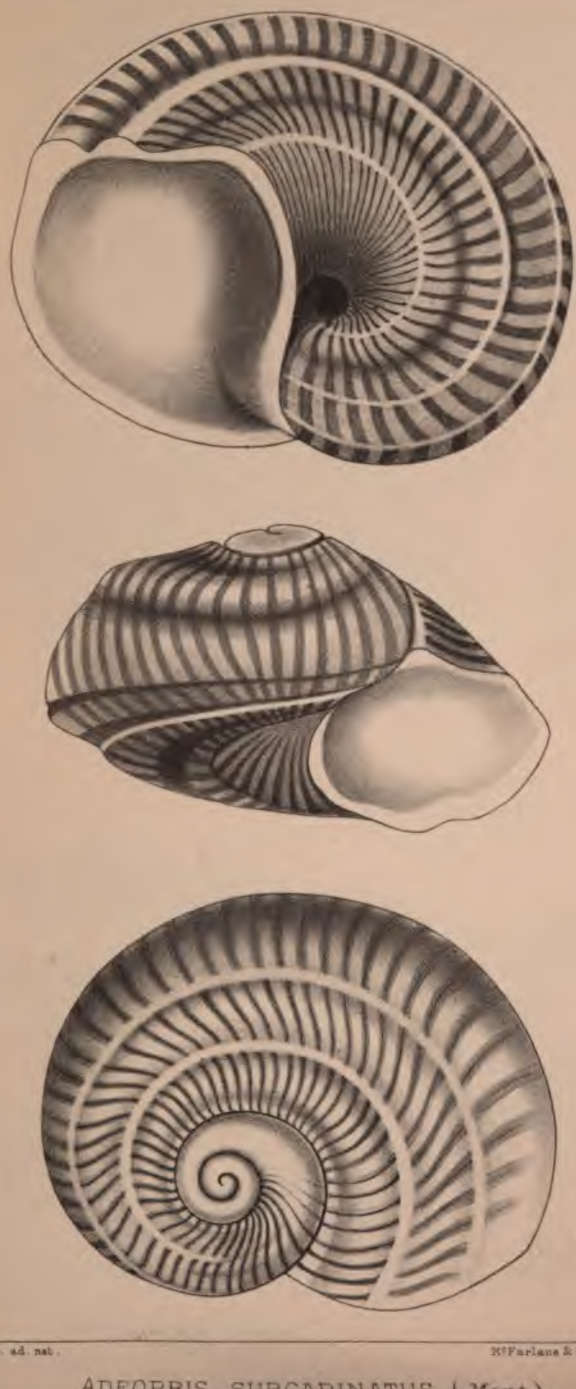

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ADEORBIS SUBCARINATUS (*Mont.*).

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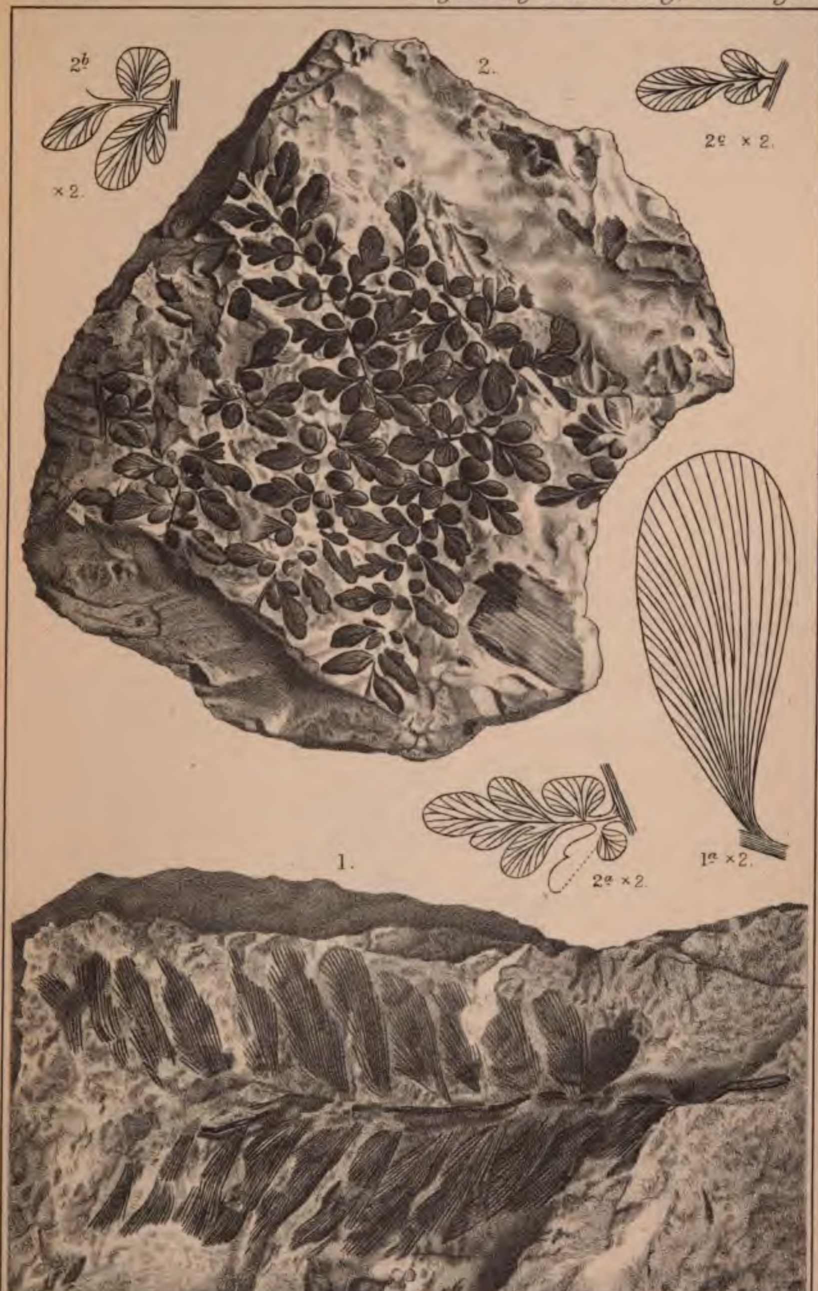
PLATE IX.



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SPHENOPTERIS POLYPHYLLA, *Lindley & Hutton*.

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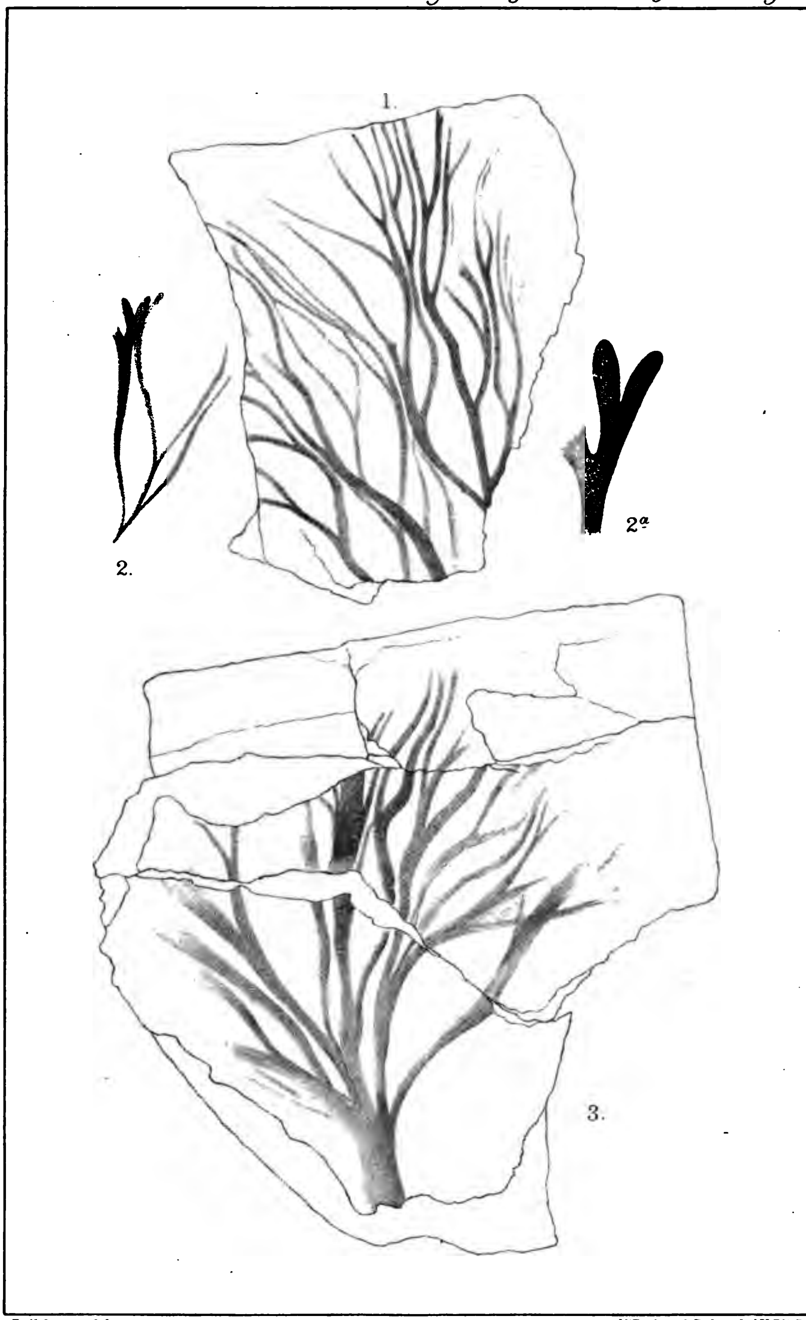

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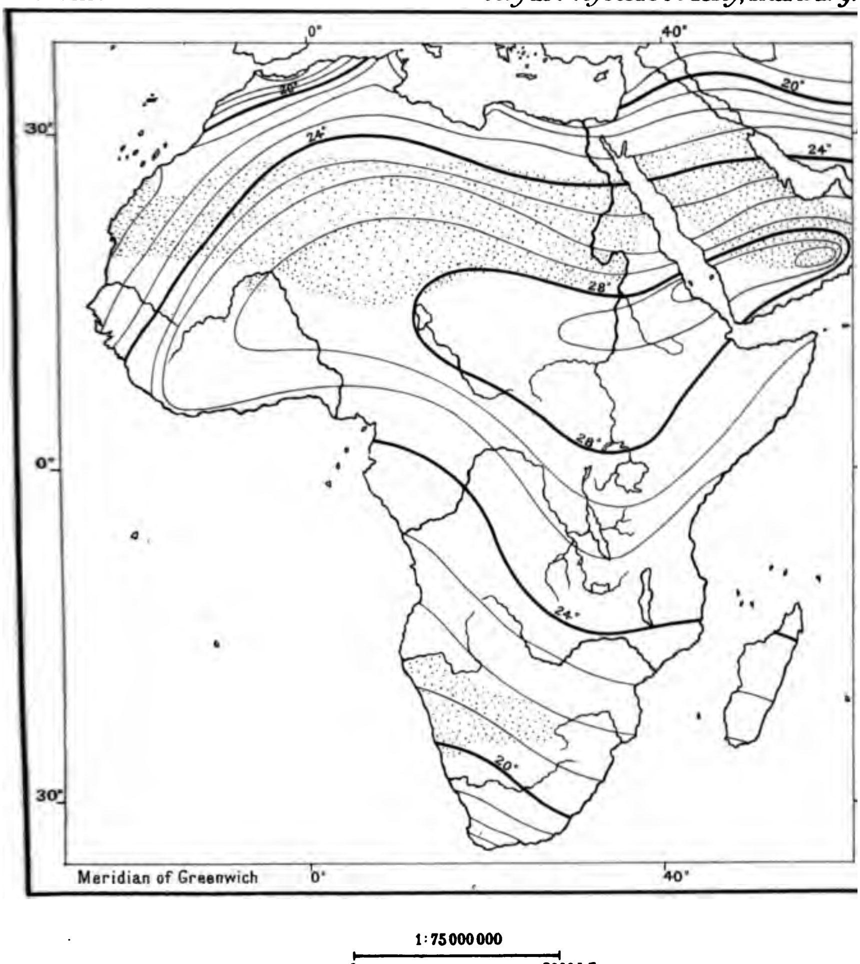

TEMPERATURE, *after Reclus.*

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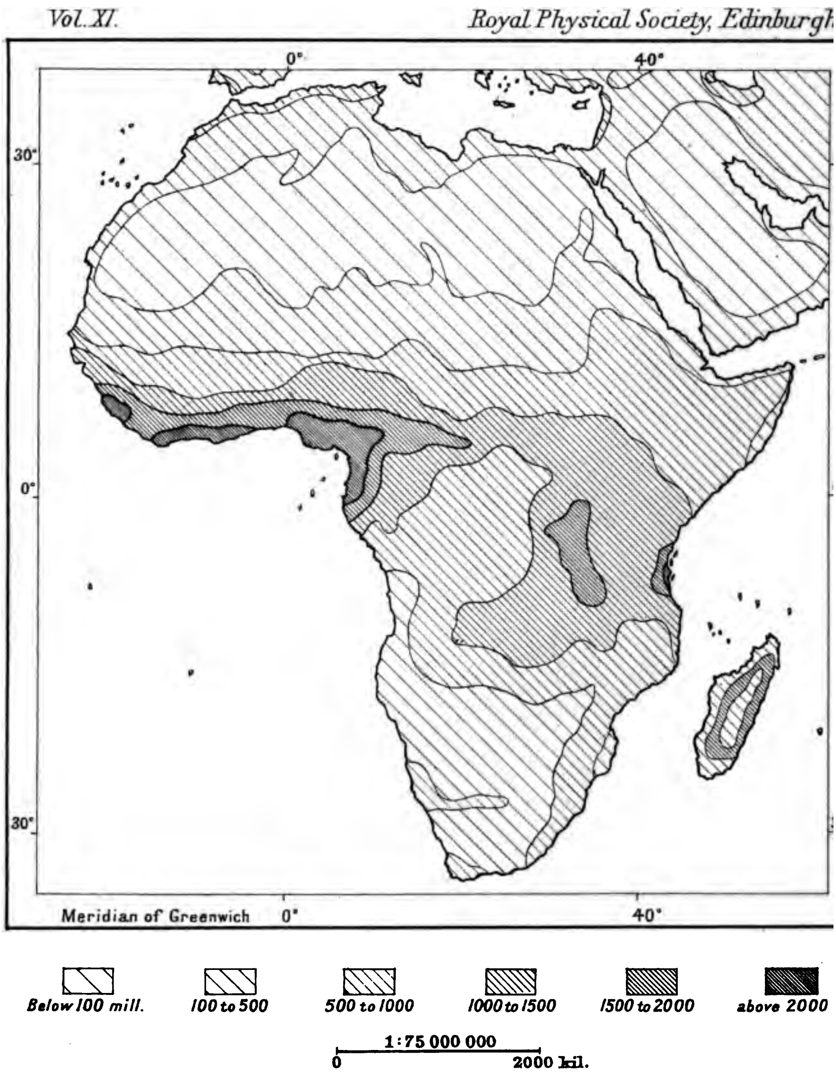

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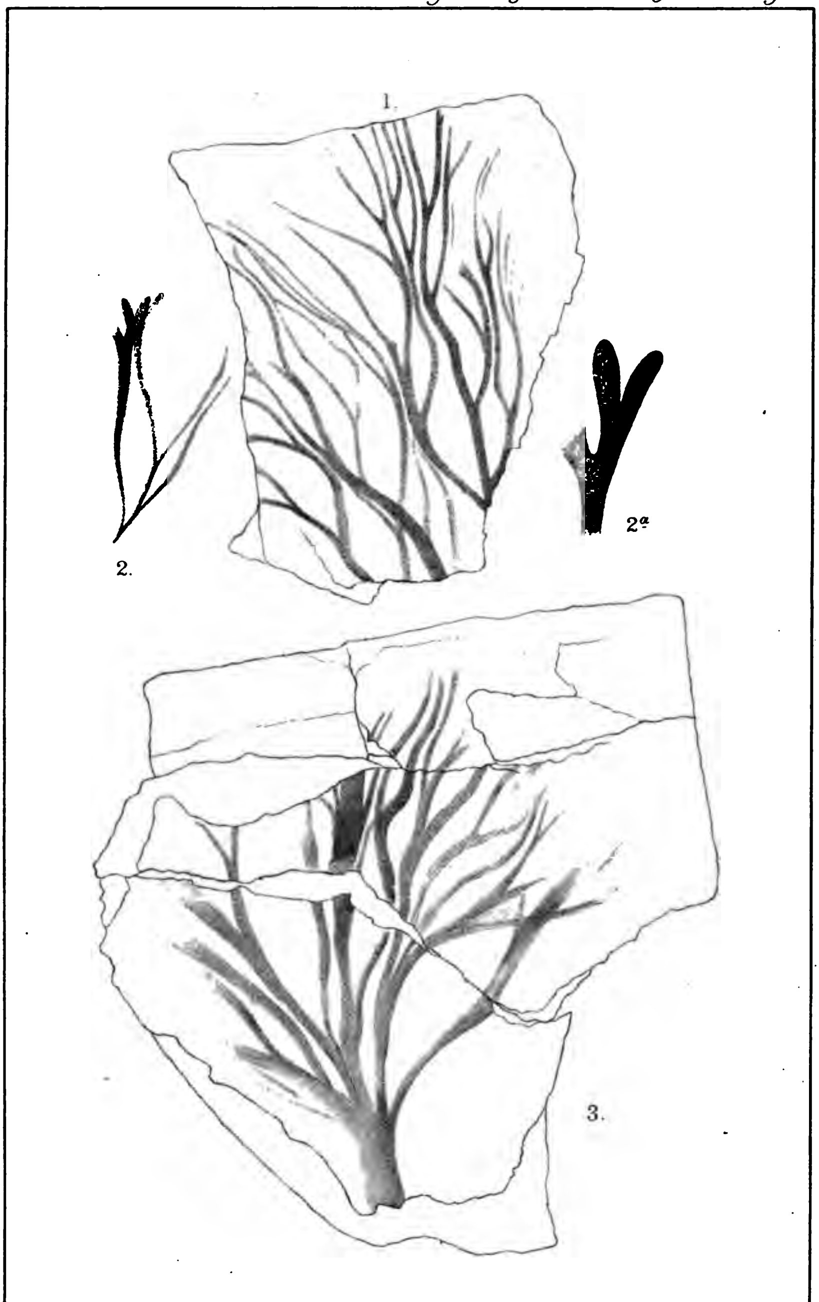

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